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# TECHNICAL NOTE

## D-1768

AN EXPERIMENTAL EVALUATION OF AERODYNAMIC  
DAMPING MOMENTS OF CONES WITH  
DIFFERENT CENTERS OF ROTATION

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
WASHINGTON

March 1963

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SUMMARY

140<sup>29</sup>

The static and dynamic stability characteristics of a  $12\frac{1}{2}^{\circ}$  semivertex angle cone were studied. The cone was tested with both sharp and blunt tips and with a flat base and spherical segment afterbodies. The tests were performed at Mach numbers from 0.25 to 2.20 for angles of attack from  $-13^{\circ}$  to  $+18^{\circ}$ . The Reynolds number varied from 0.68 million to 1.54 million based on model base diameter. Presented are measurements of the normal force, axial force, base pressure, and pitching moment from the static tests, and the damping-in-pitch moment from the dynamic tests. The reduced frequency varied from 0.013 to 0.133 during the oscillatory tests.

The damping-in-pitch moments were measured for three moment centers. The measured values from two of the moment centers were then used to compute the damping moment for the third location, and the transferred and the measured damping were compared. The transfer technique was found to be valid for the models investigated.

Tests with different sting diameters and lengths showed that, in general, the damping moment was not sensitive to variations of sting geometry.

INTRODUCTION

Wind-tunnel measurements of aerodynamic damping of models of flight vehicles are frequently made with a small-amplitude single-degree-of-freedom balance system. A typical forced-oscillation system is described in reference 1. The balance portion of this system is generally instrumented so that the damping is measured only about the oscillation axis of the balance. Design changes in the flight vehicle may make it imperative to know the damping about some other moment center and since additional wind-tunnel tests are not always possible, one would like to be able to compute the damping about the new moment center from the data already available. With the method used in reference 2 to transfer the damping moment it is necessary to know the damping about two moment centers in order to

compute the value for a third. Because of the poor agreement between the transferred and measured damping in reference 2 where damping moments were transferred in order to compare data from two wind tunnels, there was a question of whether this method could be used for blunt reentry type bodies. The present investigation was therefore undertaken to check experimentally the use of the transfer technique on reentry shapes.

The basic configuration for the study, a 12-1/2° semivertex angle cone, was tested with a sharp tip and with a blunt spherical tip. Both models were tested with flat bases and spherical segment afterbodies. The results of static and dynamic measurements are presented for all the configurations so that not only could the accuracy of the transfer of the damping moment be checked but the data would be sufficiently complete for fundamental research information. The tests were conducted in the Ames 6- by 6-Foot Supersonic Wind Tunnel at Mach numbers from 0.25 to 2.20.

To determine the significance of model-support interference, the effects of sting length and diameter on the damping in pitch were also evaluated at angles of attack near 0° and Mach numbers of 0.65, 1.00, and 1.60.

#### SYMBOLS

$C_A$	total axial-force coefficient, $\frac{\text{axial force}}{(1/2)\rho V^2 S}$
$C_D$	total drag coefficient, $\frac{\text{drag force}}{(1/2)\rho V^2 S}$
$C_{D_0}$	total drag coefficient at zero angle of attack
$C_L$	lift coefficient, $\frac{\text{lift force}}{(1/2)\rho V^2 S}$
$C_{L_\alpha}$	lift-curve slope at zero angle of attack, $\frac{\partial C_L}{\partial \alpha}$ , per radian
$C_m$	pitching-moment coefficient, $\frac{m}{(1/2)\rho V^2 S d}$
$C_{m_q} + C_{m_{\dot{\alpha}}}$	damping-in-pitch coefficient, $\frac{\partial C_m}{\partial (qd/V)} + \frac{\partial C_m}{\partial (\dot{\alpha}d/V)}$ , per radian
$C_{m_\alpha}$	variation of pitching-moment coefficient with angle of attack at zero angle of attack, $\frac{\partial C_m}{\partial \alpha}$ , per radian
$C_N$	normal-force coefficient, $\frac{N}{(1/2)\rho V^2 S}$
$C_{N_q} + C_{N_{\dot{\alpha}}}$	damping-in-pitch normal-force coefficient, $\frac{\partial C_N}{\partial (qd/V)} + \frac{\partial C_N}{\partial (\dot{\alpha}d/V)}$ , per radian

$C_{N_\alpha}$	variation of normal-force coefficient with angle of attack at zero angle of attack, $\frac{\partial C_N}{\partial \alpha}$ , per radian
$C_{P_b}$	base pressure coefficient, $\frac{p_b - p_s}{(1/2)\rho V^2 S}$
d	body maximum diameter
K	reduced frequency parameter, $\frac{\omega d}{V}$
M	Mach number
m	pitching moment
$m_q + m_\alpha$	damping-in-pitch moment, $\frac{\partial m}{\partial(qd/V)} + \frac{\partial m}{\partial(\dot{\alpha}d/V)}$
$m_\alpha$	variation of pitching moment with angle of attack, $\frac{\partial m}{\partial \alpha}$
N	normal force
$N_q + N_\alpha$	damping-in-pitch normal force, $\frac{\partial N}{\partial(qd/V)} + \frac{\partial N}{\partial(\dot{\alpha}d/V)}$
$N_\alpha$	variation of normal force with angle of attack, $\frac{\partial N}{\partial \alpha}$
$p_b$	static pressure at model base, measured at the opening in the model base and at the side of the sting
$p_s$	free-stream static pressure
q	pitching velocity, radians/sec
R	Reynolds number based on d
S	base area, $\frac{\pi d^2}{4}$
t	time
V	free-stream velocity
x	transfer distance, positive toward base of model
$\alpha$	angle of attack
$\dot{\alpha}$	variation of angle of attack with time, $\frac{\partial \alpha}{\partial t}$ , radians/sec

$\rho$	air density
$\omega$	circular frequency of oscillation, radians/sec

#### Subscripts

$o, 1, 2$	moment center locations
$o-1, o-2$	distance between moment centers, positive toward model base

#### APPARATUS

##### Wind Tunnel and Balances

The aerodynamic measurements were made in the Ames 6- by 6-Foot Supersonic Wind Tunnel. This wind tunnel is a closed-circuit variable density type with the floor and ceiling perforated to permit testing at transonic Mach numbers. The Mach number range is from 0.25 to 2.20.

The static aerodynamic forces and moments were measured by means of a conventional six-component strain-gage balance within the model. The balance and models were supported in the wind tunnel by a 2-inch-diameter sting.

The aerodynamic damping moments were measured with a single-degree-of-freedom forced-oscillation system which permits a small amplitude of oscillation (about  $\pm 3-1/2^\circ$ ). A similar balance system is shown in reference 1. The balance on which the model was mounted is essentially a set of crossed flexures that act as a mechanical spring and also fix the oscillation axis of the model. The model is driven by an electromagnetic shaker in a pitching motion, and oscillates at some predetermined amplitude and at the natural frequency of the system. The information necessary to compute the damping moment was obtained from a calibrated strain-gage system within the balance. The models were sting mounted as shown in figure 1.

#### Models

The basic shape of the models of this investigation was a right circular cone with a  $12-1/2^\circ$  semivertex angle. One version of the model had a pointed nose and another had a spherically blunted nose. In addition, the models were tested with flat bases and with spherical segment afterbodies. Sketches of the models are shown in figure 2(a). The purpose of the spherical segment afterbodies was to minimize the moment contribution of the base so that the forebody damping could be measured. The radius of each afterbody was chosen so that the center of the sphere coincided with the center of moments. The line of action of pressure

forces on the base then passed through the moment center and, aside from the tangential friction forces, the resultant base moment was zero.

A solid model was used during most of the tests, but during the test concerned with sting interference effects, a partly hollow model was also used. Figure 2(b) shows the shape of the hollow chamber.

In order to allow the model to oscillate without hitting the sting, the clearance hole in the base of the model was made fairly large. The hole was circular and gave a clearance of about 3/8 inch all around the sting.

The maximum diameter of the models was 6.36 inches. This gives a ratio of 0.00614 for the model maximum area to the cross-section area of the wind-tunnel test section.

#### Sting Configurations

For most of the oscillation tests, the sting was 2 inches in diameter and had a pair of stiffener plates perpendicular to the oscillation axis of the model (see fig. 2(c)). These plates minimized sting deflection and reduced unwanted vertical motion of the model moment center. For the static tests, a plain 2-inch-diameter sting was used.

In the phase of the investigation concerned with the effects of sting length and diameter on the damping moment, the sting length and diameter were varied by means of fairings. No sting stiffener plates were used in this phase of the test. Figure 2(c) is a sketch of the different sting configurations. The length was varied by use of a sheet-metal cone representing the conical portion of the basic model support that could be moved along the sting and positioned at any location. The three sting lengths studied were the normal full length (basic) sting, half normal length, and zero length.

The variation of sting diameter was accomplished by the addition of constant diameter wood sleeves around the sting. The three diameters considered were 2, 2-1/2, and 3 inches. The sleeves extended inside the model base so that it was necessary to enlarge the circular hole in the model base to accommodate the larger sting diameters.

#### TESTS AND PROCEDURES

Measurements were taken during the static and oscillation tests for Mach numbers from 0.25 to 2.20 and angles of attack from  $-13^{\circ}$  to  $+18^{\circ}$ . The variation of Reynolds number with Mach number is shown in figure 3.

The quantities measured during the static tests were the normal force, axial force, pitching moment, and the base pressure. The axial-force data presented in the report are the total axial forces acting on the strain-gage balance with no adjustment of the base pressure.

The quantity measured during the oscillation tests was the aerodynamic damping moment from which the parameter  $C_{m_q} + C_{m_\alpha}$  was evaluated. The measurements were made at reduced frequencies from 0.013 to 0.133. The damping moments were measured with the model set at a nominal angle of attack and then oscillated  $\pm 1/2^\circ$  about this position. The damping moments were measured about all three of the moment centers shown on figure 2(a).

As previously stated, the models were constructed with either a flat or a spherical segment base. For oscillation tests conducted with a spherical based configuration, the center of the spherical segment always coincided with the particular moment center or oscillation axis being used.

#### Accuracy

The accuracy of the data estimated from repeated measurements is as follows:

	<u>Static data</u>	<u>Dynamic data</u>
$C_A$	$\pm 0.010$	$C_{m_q} + C_{m_\alpha}$ $\pm 0.10$
$C_N$	$\pm 0.004$	$K$ $\pm 0.0001$
$C_m$	$\pm 0.001$	
$C_{p_b}$	$\pm 0.003$	
$\alpha$	$\pm 0.10$	

#### RESULTS AND DISCUSSION

##### Transfer Equation

The equations for transferring rotary aerodynamic derivatives from one pitch axis location to another are frequently given in dynamic stability literature. For an arbitrary displacement in only the longitudinal direction of the origin of the system of axes (moment center) the equations are considerably simplified. A derivation of the transfer equation for aerodynamic damping-in-pitch moment for an arbitrary longitudinal displacement of the moment center is given in the appendix and the equation is repeated here in conventional coefficient form:

$$(C_{m_q} + C_{m_\alpha})_o = (C_{m_q} + C_{m_\alpha})_1 + \frac{x_{o-1}}{d} (C_{N_q} + C_{N_\alpha})_1 - \frac{x_{o-1}}{d} (C_{m_\alpha})_1 - \left( \frac{x_{o-1}}{d} \right)^2 C_{N_\alpha}$$

This equation, of course, was derived with the usual limitations and assumptions

involved in stability derivative concepts. The derivatives are assumed linear, at least for small variations of  $\alpha$ ,  $\dot{\alpha}$ , and  $q$ , and the principle of superposition is employed.

From the transfer equation it can be seen that in order to compute the damping moment for center (0), not only the damping moment for location (1) but also the damping normal force and the static stability characteristics must be known. With the measurement system employed for the data of this report, only a dynamic moment about the oscillation axis of the balance and the static stability characteristics are obtained. As a result, in order to transfer damping moments with this system, it is necessary to measure the damping moment for two locations of the oscillation axis and the static stability characteristics. If the damping normal force is eliminated from the moment transfer, the following equation is then obtained:

$$(C_{m_q} + C_{m_{\dot{\alpha}}})_0 = \frac{\frac{x_{0-1}}{d} (C_{m_q} + C_{m_{\dot{\alpha}}})_2 - \frac{x_{0-2}}{d} (C_{m_q} + C_{m_{\dot{\alpha}}})_1}{\left(\frac{x_{0-1}}{d} - \frac{x_{0-2}}{d}\right)} - \left(\frac{x_{0-1}}{d}\right) \left(\frac{x_{0-2}}{d}\right) C_{N_{\alpha}}$$

The subscripts on the damping derivatives refer to the moment center locations and the terms  $x_{0-1}$  and  $x_{0-2}$  are the distances between the moment centers. The transfer distances are measured from the moment center about which the damping moment is to be computed to the moment centers where the damping is known (distances measured toward the rear of the model are considered positive).

#### Damping-Moment Transfer

One purpose of the present investigation was to check the adequacy of the damping-moment transfer relationship for an axisymmetric entry-type body. This type of vehicle would have a fairly blunt forebody and a large base area. It would also be likely to have stability characteristics somewhat nonlinear with angle of attack. The procedure of the study was to measure the damping moments about three moment centers and then compute the damping for each location using the measured damping values from the other two. A comparison was then made between the measured and transferred values.

The variations of the damping-in-pitch coefficients with angle of attack are shown in figure 4 for the sharp and blunt cones with both flat and rounded bases. Both the measured values of damping and the transferred values are shown. Data are compared only for Mach numbers 0.65, 1.00, 1.30, and 2.20, which are considered representative of the subsonic, transonic, and supersonic speed ranges. Measured data for other Mach numbers are included in table I. It should be noted that the transfer was made using the damping values shown by the curves faired through the measured readings. This was necessary since the data for the various moment centers rarely were taken at identical angles of attack.

The agreement between the measured and transferred data as shown on figure 4 varies a great deal depending on Mach number and configuration. For the majority of the data the agreement is good; that is, the transferred data give a

reasonable value of the damping as compared with the measured value. In other cases the agreement ranges from fair to poor. It appears that throughout the Mach number range the agreement was better for the blunt cone than for the sharp cone.

It is not clear why there is such a variation in agreement between the measured and the transferred data. Nonlinearity with angle of attack does not seem to be the reason since the blunt cones at  $M = 1.00$  have measured data that are nonlinear and the transferred points are generally in good agreement. One possibility is that the transfer equation shows that for the small moment center transfer distances considered in this investigation, the transfer is nearly linear with moment center location. The discrepancies may therefore be the result of some nonlinearity with moment center movement not accounted for in the derivation of the transfer equation. The most likely reason for the poor agreement is that the transfer computation involves the difference between two numbers of similar magnitudes which may tend to magnify small irregularities in the measured damping readings.

For the sharp cone with the spherical base, damping was measured for only the middle moment center (fig. 4(c)). This means, of course, that no transfer of the damping moment could be made. The data for this model are included throughout the report because they may be of general interest since the shape is related to the others considered in the report.

The static characteristics for the models are shown in figure 5. As with the damping data, results are shown only for Mach numbers of 0.65, 1.00, 1.30, and 2.20. Data for other Mach numbers are presented in table II. Figure 5 also shows that the value of  $C_{N\alpha}$  is nearly constant with angle of attack for all models.

Figure 6 shows the variation of the zero angle-of-attack values of both the static and dynamic stability derivatives with Mach number. One set of transferred damping moments is also shown, as well as a comparison of measured damping with linear theory for the sharp cone. Comparing the transferred and measured damping shows that the transfer is generally satisfactory throughout the Mach number range. The data for the sharp cone show somewhat poor agreement in the transonic and subsonic speed ranges, but those for the blunt cone show good agreement throughout the entire range. The poor agreement for the sharp cone would be expected in light of figure 4.

The comparison of the linear theory with the experimental data shown in figures 6(a) and 6(b) shows good agreement for the static characteristics and reasonable agreement for the damping in pitch. The theory shown is the combination first- and second-order linear theory given in reference 3 applicable to sharp-nosed cones. A comparison of the theoretical damping value with the measured damping for both the cone with the flat base and with the spherical base shows that the theory agrees best for the model with the spherical base, as would be expected.

The effect of the alternate oscillation axes on the zero angle-of-attack values of damping moment coefficients is shown in figure 7. The linear theory values for the sharp cone and the transferred damping moments for all the bodies

are shown. Both the transferred and the theoretical damping show the same trends as the measured values for movement of the moment center.

### Shape Changes

In addition to the variation of damping due to movement of the moment center, figure 7 also shows the effect of blunting the nose of the cone and the effect of the addition of the spherical base. Both of these modifications had a destabilizing effect on the damping. As seen in figures 4 and 6, this destabilizing shift is typical throughout the entire Mach number range and also throughout most of the angle-of-attack range. The most pronounced change occurred at subsonic Mach numbers with the addition of the spherical base where the damping became unstable for both the sharp and the blunt cones. These changes in damping level are similar to those shown in reference 2.

### Sting Interference

A second phase of the investigation was concerned with possible sting interference effects on the damping moments for the model shapes under consideration. Since the base has a sizable effect on the damping, especially at subsonic speeds, it was reasoned that the sting configuration might also have some effect. The round-nosed cone with both the flat and the spherical bases was used for this part of the investigation. The damping was measured only at Mach numbers of 0.65, 1.00, and 1.60 and at zero angle of attack.

The damping was measured for three sting diameters and for three lengths of the 2-inch-diameter sting with the hollow model. Since the sting used for these tests did not incorporate the stiffeners previously described, the solid model was also tested with the unstiffened 2-inch-diameter sting. (Figure 2(b) is a sketch of the various sting configurations.)

As can be seen on figure 8, the damping was not affected by changes in sting length or diameter, or by the presence of the stiffener plates at the supersonic or sonic speeds for the model with either the flat or spherical bases. This was also true at a Mach number of 0.65 for the model with the flat base. However, at a Mach number of 0.65 for the model with the spherical base there was a significant effect on the damping as a result of both diameter and length, and also some effect due to the stiffeners. The variation of sting diameter caused the greatest change in damping and it appears that even the smallest diameter used was not small enough to eliminate the effect on damping. The variation of sting length also caused a change in damping level but the longest sting (the length used for the data previously described) appears to be sufficiently long to eliminate sting length effects. The reasons for the damping variation with sting configuration for the model with the spherical base and not for the flat-based model are not apparent. The damping variation with sting configuration would be less with the spherical base than with the flat base if the predominate effect of the sting on the damping were the result of base-pressure effects.

#### CONCLUDING REMARKS

The results of the present investigation show that the usual method of computing the damping-in-pitch moments for an arbitrary moment center from damping values measured at two other moment centers gave satisfactory agreement between the transferred and measured damping of both the sharp- and blunt-nosed cones. The transfer was satisfactory whether the damping was stable or unstable even when the measured damping was nonlinear with angle of attack.

It was also shown that the effect of either blunting the nose of the cone or changing from a flat to a spherical base caused a decrease in the damping-in-pitch moments. In the subsonic speed range this shift in damping for the change from the flat to spherical base was large enough to change the damping from stable to unstable. The damping-in-pitch moment of the blunt cone with either the flat or spherical base was not affected by changes in sting length or diameter at transonic or supersonic speeds. Such was also the case with the flat base at  $M = 0.65$ . With the spherical base at  $M = 0.65$ , however, there was a significant effect of both sting length and diameter on the damping-in-pitch moment within the ranges investigated.

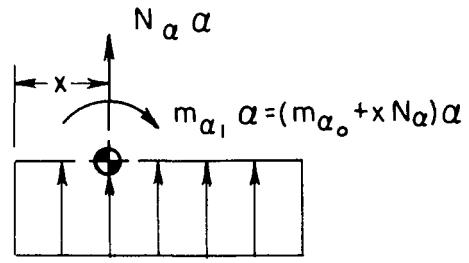
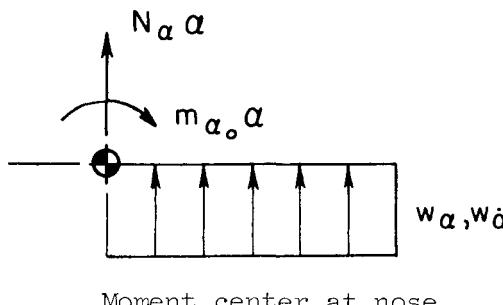
Ames Research Center  
National Aeronautics and Space Administration  
Moffett Field, Calif., Jan. 11, 1963

## APPENDIX

### DERIVATION OF THE TRANSFER EQUATION FOR DAMPING MOMENTS

In the analysis that follows, the transfer equation is derived by considering the change in the forces and moments on the body produced by changes in downwash distribution as the pitch axis location is moved. It is assumed that the transfer takes place in a direction perpendicular to the normal force vector so that any contribution of the axial force to the damping in pitch is zero. In addition, the forces and moments due to angle of attack are considered separately and then summed to give the final moment equation. To simplify the analysis, it will be assumed that the transfer is to be made between a rotation axis at the nose of the body and some point aft a distance  $x$  from the nose. It is not necessary that one of the transfer points be the nose of the body. The resulting transfer equation will be the same for transfer between any two moment center locations.

The first point to be considered is the summation of moments due to the effects of angle of attack,  $\alpha$ , and time rate of change of angle of attack,  $\dot{\alpha}$ . In both cases, the downwash, or crossflow, will be uniform along the body length. This downwash will give rise to some normal force and pitching moment at the nose of the body (sketch (a)).

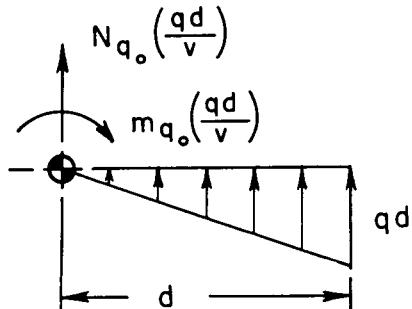


Sketch (a)

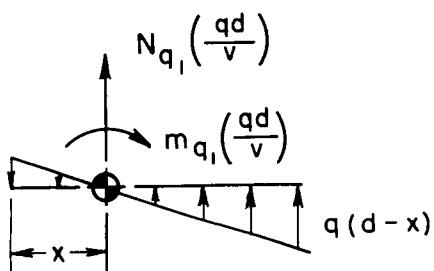
For some other moment center the downwash distribution along the body in a pure plunging motion does not change. As a result, the normal force is the same but the pitching moment about this other moment center is different. This is shown on the right side of sketch (a). As a result, the following moment equations can be written. The moments and forces have been changed to coefficient form by dividing by  $[(1/2)\rho V^2 S d]$ .

$$C_{m_{\alpha_1}} = C_{m_{\alpha_0}} + \frac{x}{d} C_{N_{\alpha}}$$

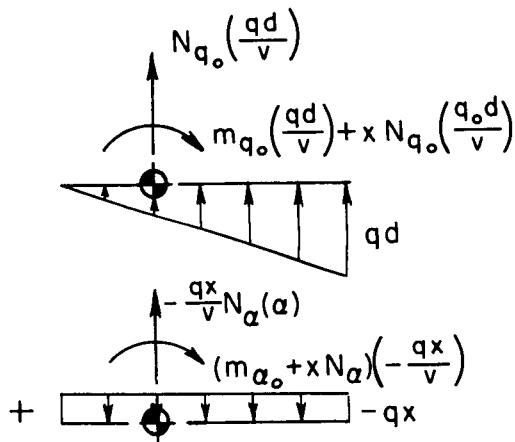
$$C_{m_{\dot{\alpha}_1}} = C_{m_{\dot{\alpha}_2}} + \frac{x}{d} C_{N_{\dot{\alpha}}}$$



Sketch (b)



=



Sketch (c)

uniform angle-of-attack type downwash proportional to the pitch rate and distance the moment center was moved. The moments and forces for each of these downwash distributions are shown (sketch (c)) resolved about moment center 1. Summing the moments due to the pitching and plunging downwash results in the following equation changed to coefficient form by dividing by  $[(1/2)\rho V^2 S d]$ .

$$C_{m_{q_1}} = C_{m_{q_o}} + \frac{x}{d} C_{N_{q_o}} - \frac{x}{d} C_{m_{\alpha_o}} - \left(\frac{x}{d}\right)^2 C_{N_{\alpha}}$$

The damping coefficient is the sum of the  $q$  and  $\dot{\alpha}$  terms so the final transfer equation is,

$$(C_{m_q} + C_{m_{\dot{\alpha}}})_1 = (C_{m_q} + C_{m_{\dot{\alpha}}})_o + \frac{x}{d} (C_{N_q} + C_{N_{\dot{\alpha}}})_o - \frac{x}{d} C_{m_{\alpha_o}} - \left(\frac{x}{d}\right)^2 C_{N_{\alpha}}$$

A more detailed derivation of the above transfer equation is given in reference 4, where the transfer is considered with both a horizontal and a vertical translation of the pitch axis.

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3. Tobak, Murray, and Wehrend, William R.: Stability Derivatives of Cones at Supersonic Speeds. NACA TN 3788, 1956.
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TABLE I.- DAMPING-IN-PITCH DATA

(a) Sharp cone with flat base; center of moments at 0.834d from model base

$\alpha$	$C_{m_q} + C_{m_{\dot{\alpha}}}$	K	$\alpha$	$C_{m_q} + C_{m_{\dot{\alpha}}}$	K	$\alpha$	$C_{m_q} + C_{m_{\dot{\alpha}}}$	K
M = 0.25								
-02.1	-1.055	.0832	-01.9	-2.247	.0227	-01.9	-1.545	.0160
-03.2	-1.190	.0827	-01.0	-2.356	.0225	-02.9	-1.422	.0161
-05.1	-1.327	.0826	00.8	-2.503	.0225	-04.6	-1.141	.0161
-02.1	-1.215	.0821	-01.8	-1.932	.0226	-02.0	-1.395	.0161
-01.1	-1.209	.0821	-02.7	-1.779	.0227	-01.3	-1.485	.0160
00.8	-1.177	.0830	-04.6	-1.795	.0229	00.6	-1.546	.0161
03.8	-1.351	.0825	-07.1	-1.355	.0231	-07.2	-1.017	.0162
06.8	-1.309	.0824	-10.1	-1.256	.0233	-09.8	-0.941	.0162
09.7	-1.485	.0818	-12.4	-1.285	.0232	-12.3	-0.987	.0163
12.7	-1.320	.0813	-13.3	-1.255	.0233	-13.1	-1.039	.0163
15.8	-1.658	.0820						
M = 0.65								
-02.1	-1.232	.0332	-01.8	-1.893	.0210	-01.8	-1.243	.0142
-01.2	-1.165	.0332	-00.8	-2.074	.0209	-02.7	-1.347	.0143
00.7	-1.269	.0330	00.9	-2.320	.0208	-04.5	-0.814	.0144
03.6	-1.391	.0332	-01.7	-2.014	.0210	-01.8	-1.153	.0143
06.5	-1.545	.0329	-02.6	-1.995	.0210	-00.9	-1.357	.0142
09.5	-1.467	.0329	-04.6	-1.668	.0211	00.8	-1.468	.0142
12.3	-1.547	.0329	-07.1	-1.480	.0213	03.6	-1.981	.0143
14.4	-1.468	.0329	-09.8	-1.377	.0213	-07.1	-0.603	.0143
-02.1	-1.227	.0331	-12.5	-1.223	.0215	-09.7	-0.559	.0145
-03.0	-1.227	.0331	-13.2	-1.239	.0215	-12.2	-0.622	.0145
-05.0	-1.157	.0331				-13.0	-0.661	.0145
M = 1.00								
-01.8	-1.247	.0227						
-01.0	-1.356	.0225						
00.8	-2.503	.0225						
-01.8	-1.779	.0227						
-04.6	-1.795	.0229						
-07.1	-1.355	.0231						
-10.1	-1.256	.0233						
-12.4	-1.285	.0232						
-13.3	-1.255	.0233						
M = 1.10								
-01.8	-1.893	.0210						
-00.8	-2.074	.0209						
00.9	-2.320	.0208						
-01.7	-2.014	.0210						
-02.6	-1.995	.0210						
-04.6	-1.668	.0211						
-07.1	-1.480	.0213						
-09.8	-1.377	.0213						
-12.5	-1.223	.0215						
-13.2	-1.239	.0215						
M = 1.20								
-01.7	-1.570	.0198						
-00.8	-1.672	.0198						
00.9	-2.192	.0196						
-01.7	-1.527	.0198						
-02.5	-1.509	.0199						
-04.4	-1.321	.0199						
-06.9	-1.162	.0199						
-09.5	-1.262	.0200						
-12.0	-1.425	.0200						
-12.9	-1.296	.0199						
M = 1.30								
-01.8	-1.568	.0186						
-01.0	-1.886	.0185						
00.6	-2.277	.0185						
-01.9	-1.766	.0186						
-02.7	-1.808	.0187						
-04.5	-1.491	.0187						
-07.0	-1.064	.0188						
-09.5	-0.878	.0189						
-12.0	-1.106	.0189						
-12.9	-1.291	.0189						
M = 0.90								
-01.9	-2.006	.0247						
-01.0	-2.110	.0246						
00.7	-2.083	.0246						
03.6	-2.507	.0247						
-01.9	-1.926	.0247						
-02.9	-1.901	.0248						
-04.6	-1.515	.0249						
-07.2	-1.608	.0250						
-10.0	-1.366	.0251						
-12.8	-1.311	.0252						
-13.5	-1.317	.0251						
M = 2.20								
-01.4	-1.425	.0132						
-02.3	-0.599	.0132						
-04.0	-0.786	.0133						
-01.3	-1.460	.0131						
-00.4	-1.502	.0131						
01.5	-1.567	.0131						
-06.7	-0.765	.0132						
-09.4	-0.961	.0132						
-12.0	-1.112	.0133						
-13.1	-0.495	.0133						

TABLE I.-- DAMPING-IN-PTICH DATA - Continued

(b) Sharp cone with flat base; center of moments at 0.677d from model base

$\alpha$	$C_{m_q} + C_{m_d}$	K	$\alpha$	$C_{m_q} + C_{m_d}$	K	$\alpha$	$C_{m_q} + C_{m_d}$	K								
M = 0.25																
-01.4	-0.551	.0966	-01.0	-1.664	.0258	-01.4	-1.277	.0179								
-02.3	-0.538	.0972	-02.1	-1.540	.0259	-02.4	-1.103	.0179								
-04.3	-0.563	.0966	-04.1	-1.472	.0260	-04.3	-0.983	.0181								
-01.2	-0.654	.0977	-01.1	-1.575	.0257	-01.3	-1.217	.0179								
-00.3	-0.603	.0977	-00.1	-1.770	.0255	-00.3	-1.205	.0179								
01.6	-0.607	.0983	01.8	-1.854	.0257	01.5	-1.431	.0178								
04.7	-0.570	.0971	04.9	-1.767	.0256	04.6	-1.071	.0179								
07.7	-0.761	.0970	08.0	-1.654	.0259	07.6	-0.685	.0181								
10.7	-0.803	.0971	11.1	-1.212	.0261	10.5	-0.891	.0181								
13.8	-0.623	.0970	14.1	-1.162	.0261	13.5	-0.986	.0181								
16.8	-0.563	.0970	17.2	-1.305	.0260	16.5	-0.987	.0181								
M = 0.65																
-01.4	-0.700	.0384	-01.1	-1.618	.0237	-01.2	-1.382	.0160								
-02.4	-0.852	.0386	-02.1	-1.491	.0239	-02.2	-1.118	.0161								
-04.4	-0.835	.0386	-04.1	-1.324	.0241	-04.2	-1.025	.0162								
-01.4	-0.743	.0385	-01.1	-1.615	.0237	-01.2	-1.267	.0160								
-00.4	-0.735	.0384	-00.1	-1.731	.0236	-00.2	-1.046	.0160								
01.6	-0.752	.0384	01.9	-1.873	.0237	01.7	-1.075	.0160								
04.7	-0.779	.0384	04.8	-1.851	.0238	04.8	-0.792	.0161								
07.7	-0.794	.0384	08.0	-1.657	.0239	07.8	-0.741	.0162								
10.9	-0.695	.0383	11.1	-1.201	.0242	10.8	-0.608	.0162								
14.0	-0.688	.0382	14.0	-0.995	.0241	13.9	-0.837	.0162								
17.2	-0.788	.0379	17.1	-1.261	.0240	16.8	-0.721	.0161								
-01.4	-0.835	.0383	M = 1.20													
M = 0.80									M = 2.20							
-01.4	-1.043	.0318	-01.1	-1.365	.0222	-00.3	-1.086	.0149								
-02.3	-1.046	.0317	-02.0	-1.043	.0223	-01.6	-1.221	.0150								
-04.4	-0.993	.0318	-04.0	-1.120	.0223	-03.6	-0.903	.0151								
-01.3	-0.974	.0317	-01.1	-1.356	.0222	-00.6	-1.311	.0149								
-00.4	-0.927	.0316	-00.2	-1.590	.0221	00.3	-1.233	.0149								
01.6	-1.069	.0315	01.8	-1.593	.0220	02.3	-1.192	.0150								
04.7	-1.007	.0317	04.9	-1.234	.0222	05.3	-1.204	.0150								
07.8	-0.958	.0317	08.0	-1.001	.0223	08.3	-0.980	.0150								
10.8	-0.919	.0316	10.9	-0.926	.0223	11.3	-0.899	.0150								
14.0	-0.761	.0316	14.0	-1.009	.0221	14.4	-0.795	.0150								
17.2	-0.969	.0311	17.2	-1.196	.0220	17.3	-0.792	.0150								
M = 0.90									M = 1.30							
-01.1	-1.331	.0282	-01.3	-1.410	.0208											
-02.2	-1.334	.0281	-02.3	-1.186	.0209											
-04.2	-1.187	.0283	-04.3	-1.069	.0211											
-01.2	-1.549	.0282	-01.2	-1.392	.0209											
-00.2	-1.425	.0282	-00.3	-1.598	.0209											
01.8	-1.478	.0282	01.7	-1.846	.0208											
04.8	-1.333	.0282	04.7	-1.050	.0210											
07.9	-1.398	.0284	07.7	-0.834	.0212											
10.9	-1.293	.0284	10.8	-0.876	.0211											
14.1	-1.329	.0283	13.7	-1.122	.0210											
17.2	-1.405	.0283	16.8	-1.179	.0208											

TABLE I.- DAMPING-IN-PITCH DATA - Continued

(c) Sharp cone with flat base; center of moments at 0.520d from model base

$\alpha$	$C_{m_q} + C_{m_{\dot{q}}}$	K	$\alpha$	$C_{m_q} + C_{m_{\dot{q}}}$	K	$\alpha$	$C_{m_q} + C_{m_{\dot{q}}}$	K
M = 0.25								
-00.4	-0.805	.1104	-00.2	-1.112	.0278	-00.6	-1.090	.0193
-01.5	-0.805	.1111	-01.3	-0.994	.0278	-01.7	-0.938	.0194
-03.5	-0.721	.1105	-03.6	-1.120	.0279	-03.9	-0.853	.0195
-00.4	-0.624	.1098	-00.2	-0.872	.0277	-00.6	-1.070	.0192
00.5	-0.617	.1097	00.7	-0.977	.0276	00.4	-1.017	.0193
02.5	-0.678	.1117	02.9	-1.125	.0276	02.6	-1.120	.0192
05.5	-0.680	.1116	06.3	-0.987	.0278	06.1	-0.856	.0193
08.6	-0.747	.1110	09.9	-0.818	.0281	-05.5	-0.865	.0163
11.7	-0.415	.1110	13.2	-0.830	.0280	12.9	-0.697	.0193
14.7	-0.272	.1097	14.4	-0.828	.0280	14.2	-0.739	.0193
17.8	-0.236	.1110						
M = 1.00								
-00.4	-0.805	.1104	-00.2	-1.112	.0278	-00.6	-1.090	.0193
-01.5	-0.805	.1111	-01.3	-0.994	.0278	-01.7	-0.938	.0194
-03.5	-0.721	.1105	-03.6	-1.120	.0279	-03.9	-0.853	.0195
-00.4	-0.624	.1098	-00.2	-0.872	.0277	-00.6	-1.070	.0192
00.5	-0.617	.1097	00.7	-0.977	.0276	00.4	-1.017	.0193
02.5	-0.678	.1117	02.9	-1.125	.0276	02.6	-1.120	.0192
05.5	-0.680	.1116	06.3	-0.987	.0278	06.1	-0.856	.0193
08.6	-0.747	.1110	09.9	-0.818	.0281	-05.5	-0.865	.0163
11.7	-0.415	.1110	13.2	-0.830	.0280	12.9	-0.697	.0193
14.7	-0.272	.1097	14.4	-0.828	.0280	14.2	-0.739	.0193
17.8	-0.236	.1110						
M = 1.10								
M = 1.60								
M = 0.65								
-00.6	-0.708	.0416	-00.3	-0.913	.0256	-00.3	-0.971	.0172
-01.6	-0.629	.0418	-01.4	-1.111	.0256	-01.4	-1.015	.0172
-03.8	-0.795	.0419	-03.6	-1.110	.0257	-03.7	-1.038	.0173
-00.5	-0.737	.0417	-00.2	-1.052	.0257	-00.4	-1.072	.0172
00.4	-0.788	.0416	00.7	-1.141	.0257	00.6	-1.051	.0172
02.5	-0.674	.0417	03.0	-1.281	.0255	02.8	-1.015	.0172
05.9	-0.758	.0417	06.3	-1.102	.0257	06.1	-0.822	.0173
09.1	-0.554	.0421	09.7	-0.890	.0259	09.5	-0.620	.0173
12.3	-0.494	.0419	13.1	-0.797	.0259	12.9	-0.789	.0172
15.6	-0.468	.0421	14.2	-0.840	.0258			
18.0	-0.590	.0421				M = 2.20		
M = 0.80								
-00.6	-0.836	.0341	-00.3	-1.002	.0236	00.2	-0.893	.0162
-01.6	-0.670	.0341	-01.4	-0.993	.0237	-00.7	-1.147	.0162
-03.9	-0.864	.0341	-03.7	-0.949	.0238	-02.5	-0.851	.0163
-00.6	-0.745	.0341	-00.3	-0.861	.0237	00.2	-0.976	.0162
00.4	-0.626	.0341	00.7	-1.015	.0236	01.3	-1.285	.0161
02.6	-0.702	.0339	02.9	-1.195	.0236	03.4	-1.057	.0162
05.9	-0.623	.0342	06.4	-0.720	.0237	06.7	-0.720	.0162
09.3	-0.501	.0343	09.8	-0.909	.0237	10.0	-0.634	.0162
12.7	-0.596	.0343	12.2	-0.901	.0237	13.3	-0.805	.0161
13.8	-0.625	.0343				16.6	-0.845	.0161
14.9	-0.635	.0342						
M = 1.30								
M = 0.90								
-00.4	-1.051	.0303	-00.6	-1.066	.0222			
-01.4	-0.865	.0305	-01.6	-1.113	.0222			
-03.7	-0.937	.0302	-03.9	-0.932	.0223			
-00.3	-0.933	.0302	-00.5	-1.099	.0222			
00.6	-0.932	.0303	00.4	-1.119	.0222			
02.8	-0.939	.0303	02.7	-1.092	.0222			
06.2	-1.011	.0303	06.2	-0.801	.0223			
09.5	-0.809	.0305	09.6	-0.887	.0223			
13.0	-0.819	.0305	13.1	-0.726	.0224			
14.1	-0.815	.0306						
15.2	-0.976	.0305						

TABLE I.- DAMPING-IN-PITCH DATA - Continued

(d) Sharp cone with spherical base; center of moments at 0.677d from model base;  
center of spherical base at 0.677d

$\alpha$	$C_{m_q} + C_{m_d}$	K	$\alpha$	$C_{m_q} + C_{m_d}$	K	$\alpha$	$C_{m_q} + C_{m_d}$	K
M = 0.25								
-01.3	0.330	.0928	-01.1	-1.381	.0256	-01.5	-0.975	.0178
-02.2	0.438	.0955	-02.1	-1.437	.0255	-02.4	-1.027	.0179
-04.2	0.344	.0955	-04.0	-1.241	.0257	-04.6	-0.749	.0179
-01.4	0.441	.0960	-01.1	-1.369	.0256	-01.3	-1.011	.0179
-00.4	0.394	.0960	-00.1	-1.429	.0256	-00.4	-1.116	.0178
01.6	0.443	.0960	01.8	-1.553	.0254	01.5	-1.102	.0179
04.7	0.637	.0953	04.9	-1.690	.0256	04.6	-1.087	.0180
07.6	0.687	.0952	08.0	-1.509	.0256	07.5	-0.584	.0180
10.7	0.688	.0949	11.0	-1.193	.0257	10.6	-0.689	.0180
13.6	-0.348	.0950	14.2	-1.033	.0256	13.6	-0.828	.0180
16.7	-0.816	.0954	17.3	-1.105	.0256	16.6	-0.864	.0179
M = 0.65								
-01.5	0.353	.0388	-01.2	-1.329	.0236	-01.1	-1.080	.0160
-02.3	0.470	.0387	-02.1	-1.269	.0236	-02.2	-0.988	.0160
-04.3	0.113	.0386	-04.2	-1.088	.0237	-04.2	-0.824	.0161
-01.4	0.470	.0387	-01.1	-1.437	.0236	-01.1	-0.995	.0159
-00.4	0.447	.0388	-00.1	-1.474	.0236	00.0	-1.000	.0159
01.5	0.588	.0388	01.8	-1.466	.0234	01.7	-1.006	.0159
04.5	0.705	.0387	04.9	-1.807	.0235	04.7	-0.638	.0160
07.6	0.709	.0384	08.0	-1.288	.0235	07.8	-0.775	.0160
10.7	0.258	.0382	11.0	-1.104	.0237	10.8	-0.760	.0160
13.7	-0.498	.0382	14.0	-1.109	.0237	13.8	-0.696	.0160
17.0	-0.715	.0378	17.2	-1.097	.0237	16.5	-0.901	.0160
M = 0.80								
M = 1.20								
-01.3	-0.174	.0320	-01.2	-1.152	.0223	-00.6	-0.730	.0148
-02.4	-0.297	.0321	-02.0	-0.822	.0221	-01.6	-0.895	.0149
-04.4	-0.369	.0319	-04.0	-0.825	.0222	-03.5	-0.853	.0149
-01.5	-0.134	.0320	-01.0	-1.003	.0223	-00.6	-1.208	.0148
-00.4	-0.216	.0321	-00.1	-1.389	.0222	00.3	-1.037	.0148
01.5	-0.115	.0320	01.8	-1.557	.0220	02.3	-0.752	.0148
04.6	-0.171	.0319	04.8	-0.972	.0220	05.3	-1.155	.0148
07.6	-0.091	.0318	07.8	-0.900	.0220	08.3	-0.661	.0149
10.7	-0.514	.0316	11.0	-1.039	.0220	11.3	-0.873	.0148
13.8	-0.913	.0314	14.0	-0.898	.0219	14.3	-0.884	.0148
17.0	-0.887	.0311	17.1	-1.147	.0217	17.3	-0.920	.0148
M = 0.90								
M = 1.30								
-01.2	-0.976	.0283	-01.2	-1.298	.0207			
-02.3	-0.872	.0286	-02.3	-0.950	.0207			
-04.2	-0.945	.0286	-04.2	-0.960	.0208			
-01.3	-0.965	.0285	-01.2	-1.330	.0207			
-00.2	-0.938	.0284	-00.2	-1.253	.0207			
01.7	-0.983	.0283	01.7	-1.520	.0208			
04.7	-1.039	.0284	04.7	-1.028	.0208			
07.8	-1.188	.0282	07.8	-0.847	.0210			
10.9	-1.031	.0284	10.7	-0.972	.0209			
13.9	-1.211	.0283	13.6	-0.796	.0208			
17.0	-1.170	.0280	16.8	-1.101	.0207			

TABLE I. - DAMPING-IN-PITCH DATA - Continued

(e) Blunt cone with flat base; center of moments at 0.562d from model base

$\alpha$	$C_{m_q} + C_{m_d}$	K	$\alpha$	$C_{m_q} + C_{m_d}$	K	$\alpha$	$C_{m_q} + C_{m_d}$	K
M = 0.25								
-01.0	-0.471	.1216	-00.7	-1.453	.0318	-00.9	-0.522	.0229
-01.9	-0.539	.1201	-01.7	-1.398	.0318	-01.7	-0.522	.0230
-03.9	-0.403	.1202	-03.6	-1.279	.0320	-03.6	-0.460	.0230
-00.8	-0.491	.1188	-00.7	-1.414	.0319	-00.8	-0.611	.0230
00.0	-0.521	.1208	00.2	-1.465	.0318	00.1	-0.633	.0229
02.0	-0.636	.1208	02.2	-1.435	.0316	01.9	-0.670	.0229
05.1	-0.488	.1207	05.2	-1.643	.0318	04.7	-0.958	.0230
08.0	-0.684	.1192	08.3	-1.574	.0319	07.4	-0.507	.0231
11.0	-0.675	.1213	11.4	-1.793	.0321	10.3	-0.471	.0231
14.1	-0.501	.1212	14.3	-1.552	.0323	12.9	-0.512	.0231
17.1	-0.396	.12?	17.3	0.045	.0332	14.6	-0.547	.0234
M = 0.65								
-01.0	-0.681	.0474	M = 1.00			-00.7	-0.283	.0206
-01.9	-0.728	.0474	-00.7	-1.409	.0292	-01.6	-0.401	.0206
-03.9	-0.772	.0476	-01.5	-1.408	.0292	-03.4	-0.542	.0206
-01.0	-0.698	.0475	-03.6	-1.336	.0295	-00.7	-0.416	.0205
00.0	-0.677	.0477	-00.6	-1.376	.0294	00.1	-0.486	.0204
01.9	-0.678	.0475	00.2	-1.507	.0292	01.9	-0.559	.0203
04.9	-0.760	.0475	02.2	-1.662	.0293	04.8	-0.897	.0203
07.9	-0.826	.0475	05.3	-1.690	.0294	07.7	-0.512	.0207
10.9	-0.714	.0477	08.3	-1.703	.0296	10.4	-0.549	.0207
13.9	-0.632	.0477	11.3	-1.742	.0296	13.1	-0.556	.0206
17.0	-0.628	.0477	14.4	-1.193	.0301	15.9	-0.606	.0206
M = 0.80								
-00.9	-0.755	.0394	M = 1.10			-00.2	-0.587	.0188
-02.0	-0.872	.0394	-00.7	-1.176	.0276	-01.0	-0.431	.0186
-03.9	-0.867	.0394	-01.7	-1.101	.0277	-02.9	-0.499	.0187
-01.0	-0.789	.0394	-03.6	-0.898	.0279	-00.2	-0.449	.0187
00.0	-0.740	.0392	-00.7	-1.176	.0276	00.7	-0.511	.0187
01.9	-0.814	.0393	00.2	-1.216	.0276	02.5	-0.397	.0186
05.0	-0.875	.0393	02.1	-1.314	.0277	05.4	-0.662	.0187
07.9	-0.876	.0394	05.1	-0.842	.0280	08.3	-0.525	.0187
10.9	-0.730	.0395	08.0	-0.751	.0282	11.4	-0.441	.0187
13.9	-0.710	.0398	11.0	-0.788	.0285	13.9	-0.476	.0190
17.0	-0.686	.0396	13.7	-0.815	.0287	16.7	-0.676	.0191
M = 0.90								
-00.7	-1.100	.0350	M = 1.20			-00.2	-0.587	.0188
-01.7	-0.988	.0351	-00.7	-1.046	.0263	-01.0	-0.431	.0186
-03.8	-1.056	.0351	-01.7	-0.805	.0263	-02.9	-0.499	.0187
-00.8	-1.073	.0351	-03.5	-0.787	.0264	-00.2	-0.449	.0187
00.1	-1.036	.0351	-00.7	-0.939	.0262	00.7	-0.511	.0187
02.1	-1.101	.0351	00.2	-1.083	.0264	02.5	-0.397	.0186
05.0	-1.221	.0351	02.0	-1.267	.0264	05.4	-0.662	.0187
08.0	-1.164	.0354	04.9	-0.691	.0266	08.3	-0.525	.0187
11.1	-0.954	.0354	07.7	-0.572	.0269	11.4	-0.441	.0187
14.0	-0.940	.0357	10.5	-0.657	.0270	13.9	-0.476	.0190
17.0	-0.818	.0359	13.3	-0.797	.0270	16.7	-0.676	.0191
M = 1.30								
-00.7	-1.000	.0350	-00.7	-1.046	.0263	-00.2	-0.587	.0188
-01.7	-0.988	.0351	-01.7	-0.805	.0263	-01.0	-0.431	.0186
-03.8	-1.056	.0351	-03.5	-0.787	.0264	-02.9	-0.499	.0187
-00.8	-1.073	.0351	-00.7	-0.939	.0262	-00.2	-0.449	.0187
00.1	-1.036	.0351	00.2	-1.083	.0264	00.7	-0.511	.0187
02.1	-1.101	.0351	02.0	-1.267	.0264	02.5	-0.397	.0186
05.0	-1.221	.0351	04.9	-0.691	.0266	05.4	-0.662	.0187
08.0	-1.164	.0354	07.7	-0.572	.0269	08.3	-0.525	.0187
11.1	-0.954	.0354	10.5	-0.657	.0270	11.4	-0.441	.0187
14.0	-0.940	.0357	13.3	-0.797	.0270	13.9	-0.476	.0190
17.0	-0.818	.0359	16.0	-0.811	.0272	16.7	-0.676	.0191

TABLE I.- DAMPING-IN-PITCH DATA - Continued

(f) Blunt cone with flat base; center of moments at 0.445d from model base

$\alpha$	$C_{m_q} + C_{m_d}$	K	$\alpha$	$C_{m_q} + C_{m_d}$	K	$\alpha$	$C_{m_q} + C_{m_d}$	K
M = 0.25								
-00.3	-0.373	.1314	00.0	-1.111	.0337	-00.3	-0.556	.0242
-01.4	-0.405	.1321	-01.2	-1.076	.0336	-01.6	-0.497	.0242
-03.3	-0.480	.1323	-03.3	-0.996	.0339	-03.4	-0.361	.0243
-03.3	-0.220	.1323	-00.1	-1.054	.0338	-00.4	-0.556	.0242
-00.3	-0.293	.1323	00.9	-1.082	.0335	00.6	-0.468	.0242
00.6	-0.360	.1321	03.1	-1.184	.0338	02.5	-0.668	.0242
02.6	-0.404	.1322	06.3	-0.892	.0337	05.6	-0.539	.0243
05.6	-0.187	.1320	09.5	-1.104	.0339	08.6	-0.271	.0245
08.6	-0.572	.1320	12.8	-1.943	.0344	11.6	-0.300	.0245
11.7	-0.259	.1322	11.7	-1.599	.0342	14.6	-0.303	.0246
14.7	-0.143	.1330	16.0	-2.698	.0357	17.5	-0.328	.0247
17.7	-0.160	.1321	18.9	-0.128	.0360			
			18.0	0.857	.0365	M = 1.60		
M = 0.65								
-00.3	-0.553	.0519				-00.3	-0.252	.0219
-01.4	-0.581	.0518	-00.1	-1.085	.0310	-01.2	-0.330	.0219
-03.5	-0.621	.0518	-01.1	-1.109	.0310	-03.1	-0.326	.0219
-00.3	-0.514	.0520	-03.4	-1.023	.0311	-00.2	-0.295	.0219
00.5	-0.551	.0518	-00.1	-1.207	.0310	00.7	-0.210	.0219
02.6	-0.481	.0518	-11.4	-1.273	.0268	02.7	-0.455	.0218
05.8	-0.654	.0519	03.0	-1.192	.0309	05.6	-0.269	.0219
08.8	-0.422	.0521	06.3	-1.042	.0313	08.7	-0.194	.0220
11.9	-0.762	.0521	09.5	-1.280	.0314	11.7	-0.265	.0220
15.0	-0.782	.0523	12.8	-1.651	.0315	14.7	-0.188	.0221
18.2	-0.753	.0525	16.1	-1.718	.0327	17.5	-0.260	.0221
			18.9	0.098	.0335	M = 2.20		
M = 0.80								
-00.4	-0.688	.0428	17.2	-0.258	.0331			
-01.4	-0.672	.0427	18.1	0.847	.0337	00.3	-0.226	.0203
-03.5	-0.707	.0426				00.6	-0.163	.0203
-00.4	-0.695	.0424	-00.2	-0.920	.0289	-02.8	-0.215	.0204
00.5	-0.701	.0425	-01.2	-0.963	.0290	00.3	-0.296	.0203
02.6	-0.666	.0424	-03.4	-0.883	.0292	03.3	-0.246	.0203
05.8	-0.690	.0425	-00.1	-0.893	.0289	06.2	-0.715	.0203
09.0	-0.699	.0426	00.7	-1.013	.0289	09.3	-0.118	.0203
12.1	-0.675	.0427	02.9	-0.937	.0291	12.3	-0.152	.0204
15.3	-0.689	.0429	06.1	-0.623	.0294	15.2	-0.190	.0204
18.6	-0.700	.0426	09.3	-0.803	.0296	18.2	-0.236	.0205
			12.5	-0.669	.0298			
M = 0.90								
-00.2	-0.700	.0372	15.7	-0.517	.0302			
-01.2	-0.748	.0372	18.7	-0.485	.0305	M = 1.30		
-03.3	-0.842	.0373						
-00.2	-0.785	.0373	-00.2	-0.775	.0274			
00.7	-0.757	.0373	-01.3	-0.710	.0276			
02.8	-0.909	.0371	-03.3	-0.637	.0277			
06.0	-0.941	.0374	-00.2	-0.831	.0275			
09.2	-0.754	.0375	00.6	-0.876	.0275			
12.4	-0.605	.0378	02.8	-0.747	.0277			
15.5	-0.549	.0379	05.8	-0.544	.0279			
18.7	-0.557	.0381	09.0	-0.453	.0282			
			12.1	-0.480	.0283			
			15.1	-0.422	.0284			
			18.1	-0.460	.0285			

TABLE I.- DAMPING-IN-PITCH DATA - Continued

(g) Blunt cone with flat base; center of moments at 0.328d from model base

$\alpha$	$C_{m_q} + C_{m_{\dot{a}}}$	K	$\alpha$	$C_{m_q} + C_{m_{\dot{a}}}$	K	$\alpha$	$C_{m_q} + C_{m_{\dot{a}}}$	K	
M = 0.25									
00.1	-0.287	.1302	00.5	-0.999	.0324	00.2	-0.603	.0232	
-00.7	-0.252	.1287	01.5	-1.040	.0323	-00.9	-0.735	.0232	
-02.8	-0.292	.1303	04.0	-1.098	.0324	-03.0	-0.516	.0232	
00.2	-0.183	.1300	00.5	-0.985	.0324	00.2	-0.628	.0232	
01.2	-0.433	.1301	-00.5	-1.048	.0323	01.2	-0.499	.0232	
03.2	-0.354	.1300	-02.9	-1.115	.0325	03.4	-0.783	.0232	
06.3	-0.397	.1293	-06.2	-0.917	.0326	06.8	-0.327	.0234	
09.2	-0.479	.1295	-09.6	-1.117	.0330	10.0	-0.318	.0236	
12.4	-0.428	.1306	-13.1	-2.707	.0334	-06.1	-0.335	.0234	
15.3	0.034	.1296	-14.2	-2.788	.0337	-09.3	-0.444	.0235	
18.4	0.066	.1300	-10.7	-1.361	.0328	-12.6	-0.874	.0235	
						-13.5	-1.172	.0235	
M = 0.65									
			M = 1.00			M = 1.60			
00.1	-0.456	.0506	00.6	-0.998	.0300	00.3	-0.477	.0214	
-00.8	-0.449	.0507	01.7	-1.115	.0301	-00.6	-0.533	.0213	
-02.9	-0.476	.0503	04.0	-1.205	.0301	-02.8	-0.419	.0212	
00.1	-0.576	.0505	00.5	-1.079	.0301	00.3	-0.433	.0213	
01.2	-0.455	.0508	-02.9	-1.122	.0301	01.4	-0.428	.0213	
03.3	-0.564	.0507	-00.9	-1.055	.0301	03.5	-0.570	.0213	
06.7	-0.596	.0510	-06.2	-0.927	.0304	06.8	-0.303	.0213	
09.8	-0.653	.0512	-09.7	-1.389	.0305	10.0	-0.251	.0214	
12.0	-0.417	.0514	-13.1	-3.359	.0310	13.2	-0.280	.0214	
			-14.5	2.638	-.0313				
M = 0.80									
				10.6	-1.804	0.0305	M = 1.90		
00.1	-0.464	.0404					00.8	-0.293	.0198
01.2	-0.589	.0402					02.0	-0.206	.0198
03.6	-0.536	.0404	00.5	-1.079	.0273	03.9	-0.270	.0198	
06.9	-0.672	.0405	01.7	-0.983	.0274	07.2	-0.305	.0198	
00.1	-0.546	.0405	03.9	-0.881	.0276	10.3	-0.041	.0198	
-00.8	-0.451	.0405	-06.7	-1.072	.0274	13.5	-0.015	.0198	
-03.0	-0.544	.0406	-02.9	-1.098	.0276	16.6	-0.283	.0198	
-06.3	-0.680	.0406	-06.5	-0.728	.0279	19.7	-0.215	.0199	
-09.5	-0.529	.0408	-09.8	-0.805	.0282	00.9	-0.361	.0197	
-13.0	-0.510	.0410	-13.1	-1.195	.0286	-02.1	-0.056	.0196	
-13.9	-0.477	.0414	-14.1	-1.036	.0285				
			00.6	-1.040	.0275				
M = 0.90									
			M = 1.20			M = 2.20			
00.3	-0.659	.0359					00.8	-0.293	.0198
01.5	-0.707	.0358	00.3	-0.854	.0261				
03.8	-0.877	.0357	-00.8	-0.885	.0261				
00.4	-0.610	.0359	-02.8	-0.856	.0263				
-00.6	-0.708	.0359	00.2	-0.787	.0261				
-02.9	-0.732	.0358	01.3	-0.842	.0262				
-06.3	-0.806	.0360	03.7	-0.579	.0263				
-09.5	-0.867	.0360	-06.4	-0.495	.0266				
-12.9	-0.697	.0363	-09.6	-0.567	.0268				
-14.2	-0.862	.0365	-12.7	-0.811	.0269				
			-13.9	-0.870	.0269				
M = 1.30									

TABLE I.- DAMPING-IN-PITCH DATA - Continued

(h) Blunt cone with spherical base; center of moments at 0.562d from model base,  
center of spherical base at 0.562d

$\alpha$	$C_{m_q} + C_{m_d}$	K	$\alpha$	$C_{m_q} + C_{m_d}$	K	$\alpha$	$C_{m_q} + C_{m_d}$	K
M = 0.25			M = 1.00			M = 1.60		
-01.0	0.646	.1187	-00.8	-0.943	.0318	-00.9	-0.328	.0228
-02.0	0.803	.1180	-01.7	-1.024	.0316	-01.9	-0.445	.0229
-04.0	0.364	.1196	-03.7	-0.962	.0319	-03.6	-0.319	.0230
-00.8	0.730	.1188	-00.7	-1.004	.0317	-00.9	-0.280	.0229
00.0	0.608	.1187	00.1	-1.008	.0318	00.0	-0.328	.0229
02.0	0.572	.1193	02.1	-1.154	.0318	01.8	-0.364	.0229
05.0	-0.351	.1184	05.2	-1.411	.0316	04.5	-0.536	.0229
08.0	0.888	.1185	08.1	-1.300	.0319	07.4	-0.335	.0230
11.0	0.460	.1205	11.4	-1.725	.0319	10.2	-0.313	.0231
14.0	0.092	.1197	14.3	-3.048	.0330	12.8	-0.437	.0232
17.0	-0.171	.1196	17.1	-1.364	.0338	15.5	-0.506	.0232
M = 0.65			M = 1.10			M = 1.90		
-00.8	0.462	.0483	-00.7	-0.993	.0292	-00.7	-0.288	.0206
-01.9	0.310	.0483	-01.6	-1.024	.0293	-01.7	-0.076	.0206
-03.9	0.387	.0483	-03.7	-0.947	.0293	-03.6	-0.181	.0206
-00.9	0.501	.0483	-00.7	-1.043	.0293	-00.8	-0.268	.0206
00.0	0.462	.0483	00.2	-1.078	.0292	00.1	-0.230	.0206
01.9	0.595	.0481	02.1	-1.226	.0292	01.9	-0.274	.0205
04.9	0.615	.0481	05.2	-1.489	.0292	04.7	-0.463	.0205
07.9	0.710	.0481	08.1	-1.348	.0292	07.6	-0.316	.0205
10.9	0.158	.0478	11.3	-1.726	.0294	10.4	-0.452	.0206
13.8	-0.377	.0474	14.3	-1.793	.0299	13.1	-0.463	.0206
16.9	-0.565	.0473	17.3	-0.274	.0311	15.9	-0.457	.0206
M = 0.80			M = 1.20			M = 2.20		
-00.9	-0.176	.0400	-00.8	-0.785	.0276	-00.3	-0.159	.0190
-01.9	-0.145	.0399	-01.9	-0.711	.0277	-01.2	-0.229	.0190
-03.9	-0.023	.0401	-03.6	-0.673	.0277	-03.0	-0.042	.0190
-01.0	-0.203	.0400	-00.7	-0.753	.0277	-00.2	-0.191	.0189
00.0	-0.091	.0398	02.0	-0.791	.0276	00.6	-0.117	.0189
01.9	-0.011	.0399	05.1	-0.584	.0277	02.5	-0.304	.0189
04.9	0.007	.0399	00.1	-0.762	.0276	05.4	-0.562	.0189
07.9	-0.203	.0397	08.1	-0.747	.0279	08.2	-0.751	.0189
10.9	-0.480	.0395	10.8	-0.735	.0281	11.2	-0.325	.0190
13.8	-0.680	.0396	13.6	-0.671	.0284	13.9	-0.334	.0190
17.0	-0.729	.0393	15.3	-0.668	.0286	16.7	-0.539	.0190
M = 0.90			M = 1.30					
-00.8	-0.646	.0358	-00.8	-0.520	.0263			
-01.7	-0.699	.0357	-01.8	-0.506	.0264			
-03.7	-0.689	.0357	-03.6	-0.431	.0264			
-00.8	-0.666	.0358	-00.9	-0.554	.0264			
00.1	-0.683	.0357	00.0	-0.496	.0264			
02.0	-0.662	.0356	02.0	-0.748	.0263			
05.0	-0.844	.0356	04.7	-0.427	.0265			
08.1	-0.807	.0356	07.6	-0.510	.0266			
11.0	-0.813	.0357	10.5	-0.580	.0267			
13.9	-0.840	.0358	13.1	-0.586	.0267			
16.8	-0.913	.0357	15.8	-0.667	.0268			

TABLE I.- DAMPING-IN-PITCH DATA - Continued

(i) Blunt cone with spherical base; center of moments at 0.445d from model base,  
center of spherical base at 0.445d

$\alpha$	$C_{m_q} + C_{m_d}$	K	$\alpha$	$C_{m_q} + C_{m_d}$	K	$\alpha$	$C_{m_q} + C_{m_d}$	K
M = 0.25								
-00.4	0.400	.1299	00.0	-0.746	.0340	-00.3	-0.363	.0242
-03.3	0.290	.1293	-01.2	-0.760	.0342	-01.4	-0.297	.0242
-01.3	0.405	.1293	-03.3	-0.815	.0341	-03.3	-0.479	.0243
-00.3	0.367	.1315	-00.1	-0.793	.0341	-00.4	-0.352	.0242
00.5	0.510	.1300	00.8	-0.763	.0340	00.6	-0.355	.0242
02.6	0.396	.1293	03.0	-0.836	.0341	02.6	-0.361	.0242
05.6	0.001	.1277	06.3	-0.835	.0341	05.6	-0.519	.0242
08.6	0.516	.1314	09.5	-1.056	.0340	08.6	-0.296	.0243
11.7	0.140	.1305	13.0	-1.969	.0342	11.6	-0.405	.0244
14.7	0.009	.1290	15.9	-2.891	.0355	14.5	-0.326	.0245
17.9	-0.262	.1298	19.0	-0.190	.0359	17.5	-0.437	.0245
			18.0	-0.256	.0359			
M = 0.65								
			M = 1.00			M = 1.60		
-00.4	0.376	.0516	-00.1	-0.748	.0311	-00.1	-0.268	.0219
-01.4	0.426	.0513	-01.2	-0.767	.0311	-01.2	-0.256	.0219
-03.5	0.407	.0515	-03.2	-0.791	.0310	-03.1	-0.262	.0219
-00.4	0.370	.0513	-00.1	-0.740	.0310	-00.2	-0.285	.0219
00.5	0.408	.0514	00.7	-0.847	.0311	00.7	-0.304	.0219
02.6	0.389	.0512	03.1	-0.877	.0312	02.7	-0.324	.0219
05.7	0.283	.0512	06.3	-0.954	.0310	05.8	-0.455	.0218
08.9	0.104	.0511	09.5	-1.225	.0310	08.7	-0.273	.0218
12.0	-0.252	.0510	12.8	-1.430	.0311	11.6	-0.336	.0219
15.0	-0.259	.0510	16.1	-1.870	.0323	14.7	-0.373	.0219
18.2	-0.359	.0510	19.1	-0.167	.0328	17.6	-0.299	.0220
			17.9	-0.241	.0326	M = 1.90		
M = 0.80								
-00.4	0.013	.0424				00.3	-0.351	.0203
-01.5	0.029	.0420				-00.7	-0.370	.0203
-03.5	0.080	.0422	-00.2	-0.721	.0290	-02.7	-0.294	.0203
-00.4	0.014	.0421	-01.3	-0.665	.0290	00.3	-0.328	.0203
00.5	0.032	.0421	-03.3	-0.636	.0291	01.3	-0.296	.0203
02.6	0.033	.0421	-00.2	-0.615	.0291	03.2	-0.291	.0203
05.8	0.001	.0418	00.7	-0.678	.0291	06.3	-0.286	.0203
08.9	-0.251	.0416	03.0	-0.609	.0291	09.3	-0.411	.0203
12.1	-0.400	.0418	06.1	-0.618	.0292	12.3	-0.259	.0203
15.3	-0.458	.0418	09.3	-0.698	.0293	15.2	-0.309	.0204
18.6	-0.461	.0418	12.6	-0.621	.0297	18.2	-0.308	.0204
			15.5	-0.405	.0300			
M = 0.90								
						18.4	-0.434	.0302
M = 1.30								
-00.2	-0.537	.0373						
-01.3	-0.564	.0373						
-03.3	-0.605	.0373	-00.3	-0.511	.0276			
-00.2	-0.528	.0374	-01.3	-0.599	.0276			
00.7	-0.527	.0373	-03.3	-0.530	.0277			
02.8	-0.526	.0374	-00.2	-0.546	.0276			
06.0	-0.578	.0376	00.6	-0.466	.0277			
09.2	-0.590	.0374	02.8	-0.496	.0277			
12.4	-0.618	.0374	05.8	-0.551	.0277			
15.5	-0.685	.0375	09.1	-0.488	.0279			
18.7	-0.651	.0377	12.1	-0.491	.0280			
			15.1	-0.472	.0281			
			18.1	-0.474	.0283			

TABLE I.- DAMPING-IN-PITCH DATA - Concluded

(j) Blunt cone with spherical base; center of moments at 0.328d from model base,  
center of spherical base at 0.328d

$\alpha$	$C_{m_q} + C_{m_d}$	K	$\alpha$	$C_{m_q} + C_{m_d}$	K	$\alpha$	$C_{m_q} + C_{m_d}$	K
M = 0.25								
00.1	0.002	.1315	00.5	-0.564	.0326	00.2	-0.266	.0232
-00.8	-0.034	.1315	01.7	-0.603	.0329	-00.8	-0.204	.0232
-02.8	-0.068	.1309	03.9	-0.722	.0327	-03.1	-0.349	.0232
00.1	0.040	.1315	00.5	-0.625	.0326	00.1	-0.198	.0232
01.1	-0.071	.1323	-00.6	-0.693	.0326	01.3	-0.218	.0232
03.1	0.035	.1317	-02.9	-0.697	.0328	03.3	-0.226	.0232
06.2	-0.073	.1315	-09.6	-1.114	.0325	06.8	-0.304	.0233
09.2	-0.139	.1301	-13.2	-2.413	.0330	10.1	-0.236	.0234
12.3	-0.114	.1301	-14.2	-3.494	.0333	13.3	-0.254	.0235
15.3	-0.111	.1309	-06.2	-0.763	.0326	16.5	-0.307	.0236
18.4	-0.178	.1295				19.7	-0.717	.0244
M = 1.00								
00.5	-0.564	.0326	00.2	-0.266	.0232			
01.7	-0.603	.0329	-00.8	-0.204	.0232			
03.9	-0.722	.0327	-03.1	-0.349	.0232			
00.5	-0.625	.0326	00.1	-0.198	.0232			
-00.6	-0.693	.0326	01.3	-0.218	.0232			
-02.9	-0.697	.0328	03.3	-0.226	.0232			
-09.6	-1.114	.0325	06.8	-0.304	.0233			
-13.2	-2.413	.0330	10.1	-0.236	.0234			
-14.2	-3.494	.0333	13.3	-0.254	.0235			
-06.2	-0.763	.0326	16.5	-0.307	.0236			
			19.7	-0.717	.0244			
M = 1.10								
00.5	-0.610	.0299	00.3	-0.172	.0212			
01.6	-0.644	.0299	-00.6	-0.162	.0212			
04.0	-0.755	.0298	-02.7	-0.016	.0211			
07.4	-0.972	.0299	00.3	-0.114	.0211			
11.1	-2.253	.0316	01.4	-0.214	.0211			
00.4	-0.676	.0298	03.6	-0.090	.0210			
-00.5	-0.647	.0299	06.8	-0.247	.0211			
-02.9	-0.696	.0299	10.0	-0.042	.0212			
-06.4	-0.910	.0299	13.2	-0.132	.0212			
-09.7	-1.139	.0299	16.6	-0.175	.0213			
-13.3	-2.956	.0305	19.5	-0.182	.0213			
-10.8	-1.488	.0300						
M = 1.20								
00.5	-0.642	.0276	01.0	-0.180	.0199			
-00.7	-0.672	.0276	-00.1	-0.280	.0199			
-03.0	-0.673	.0276	-02.3	-0.309	.0199			
00.3	-0.599	.0276	00.9	-0.152	.0199			
01.5	-0.597	.0276	02.0	-0.272	.0198			
04.0	-0.596	.0277	04.1	-0.152	.0199			
07.4	-0.655	.0278	07.1	-0.199	.0198			
11.0	-1.351	.0294	10.5	-0.019	.0199			
-06.3	-0.740	.0278	13.6	-0.076	.0199			
-09.8	-0.738	.0280	16.7	-0.226	.0199			
-13.2	-1.086	.0283	19.8	-0.128	.0200			
-14.1	-1.024	.0283						
M = 0.80								
00.1	-0.078	.0408	00.5	-0.642	.0276			
01.2	-0.092	.0408	-00.7	-0.672	.0276			
03.4	-0.133	.0407	-03.0	-0.673	.0276			
06.8	-0.181	.0406	01.5	-0.597	.0276			
00.1	-0.047	.0408	04.0	-0.596	.0277			
-01.1	-0.027	.0408	07.4	-0.655	.0278			
-02.9	-0.116	.0406	11.0	-1.351	.0294			
-06.4	-0.050	.0406	-06.3	-0.740	.0278			
-09.6	-0.288	.0404	-09.8	-0.738	.0280			
-12.9	-0.354	.0403	-13.2	-1.086	.0283			
-13.8	-0.397	.0407	-14.1	-1.024	.0283			
M = 0.90								
00.3	-0.358	.0358	00.2	-0.307	.0263			
01.5	-0.447	.0359	-00.8	-0.445	.0263			
03.8	-0.456	.0360	-03.1	-0.647	.0264			
07.2	-0.437	.0361	00.2	-0.461	.0264			
00.3	-0.453	.0360	01.4	-0.384	.0263			
-00.7	-0.452	.0359	03.7	-0.509	.0263			
-03.0	-0.496	.0360	07.1	-0.523	.0264			
-06.4	-0.560	.0361	10.6	-0.598	.0267			
-09.6	-0.642	.0360	14.1	-1.193	.0287			
-12.8	-0.617	.0361						
-13.9	-0.839	.0362						
M = 1.30								

TABLE II.- STATIC STABILITY DATA

(a) Sharp cone with flat base; center of moments at 0.677d from model base

$\alpha$	$C_m$	$C_N$	$C_A$	$C_{p_b}$		$\alpha$	$C_m$	$C_N$	$C_A$	$C_{p_b}$
$M = 0.25$										
-02.9	-0.0172	-0.116	0.347	.3544		-02.8	-0.0013	-0.091	0.602	.3790
-01.0	-0.0129	-0.068	0.337	.3621		-00.7	-0.0009	-0.029	0.607	.3841
00.0	-0.0088	-0.041	0.342	.3504		00.2	-0.0015	0.003	0.607	.3885
02.9	-0.0066	0.063	0.342	.3387		03.1	-0.0015	0.099	0.600	.3800
05.9	.0178	0.142	0.330	.3544		06.1	-0.0017	0.199	0.606	.3868
08.9	.0249	0.243	0.344	.3544		09.2	-0.0020	0.303	0.617	.4087
12.0	.0207	0.362	0.322	.3662		12.2	-0.0004	0.401	0.622	.4265
14.9	.0130	0.470	0.309	.3811		15.1	-0.0034	0.498	0.627	.4519
18.0	.0058	0.603	0.309	.4158		18.1	-0.0063	0.604	0.638	.4870
$M = 0.65$										
-03.0	-0.0093	-0.095	0.365	.3493		-02.9	-0.0019	-0.097	0.560	.3540
-00.9	-0.0042	-0.037	0.365	.3494		-00.8	-0.0010	-0.035	0.566	.3564
00.0	-0.0039	-0.010	0.366	.3425		00.1	-0.0015	-0.004	0.564	.3608
02.9	.0059	0.083	0.366	.3519		03.0	-0.0039	0.097	0.561	.3514
05.7	.0111	0.170	0.367	.3600		06.1	-0.0070	0.201	0.569	.3597
08.9	.0154	0.270	0.363	.3623		09.1	-0.0085	0.303	0.578	.3784
11.9	.0214	0.361	0.356	.3745		12.0	-0.0087	0.407	0.584	.3937
14.9	.0250	0.455	0.346	.3957		15.0	-0.0082	0.513	0.593	.4182
17.9	.0321	0.549	0.337	.4226		18.1	-0.0060	0.629	0.607	.4566
$M = 0.80$										
-03.0	-0.0061	-0.096	0.393	.3495		-02.9	-0.0011	-0.105	0.450	.2795
-01.0	-0.0026	-0.036	0.391	.3491		-01.0	-0.0001	-0.047	0.456	.2798
00.0	-0.0022	-0.005	0.391	.3512		00.0	-0.0001	-0.017	0.459	.2867
02.9	.0042	0.092	0.394	.3491		02.9	-0.0000	0.078	0.449	.2820
05.9	.0063	0.190	0.391	.3503		05.9	-0.0020	0.176	0.454	.2820
08.9	.0105	0.289	0.386	.3606		09.0	-0.0042	0.280	0.465	.2940
11.9	.0126	0.386	0.383	.3760		12.0	-0.0063	0.386	0.472	.3072
14.9	.0169	0.483	0.374	.4040		14.9	-0.0102	0.497	0.481	.3239
17.9	.0215	0.581	0.366	.4326		17.9	-0.0141	0.624	0.489	.3474
$M = 0.90$										
-02.8	-0.0042	-0.089	0.442	.3497		-02.8	-0.0007	-0.092	0.386	.2251
-00.9	-0.0031	-0.030	0.435	.3559		-00.7	-0.0011	-0.030	0.398	.2302
00.1	-0.0025	0.002	0.439	.3501		00.1	-0.0005	-0.002	0.401	.2379
03.0	.0016	0.097	0.444	.3469		03.1	-0.0012	0.093	0.390	.2366
06.1	.0031	0.198	0.440	.3544		06.0	-0.0025	0.191	0.392	.2332
09.1	.0051	0.297	0.430	.3694		09.2	-0.0041	0.296	0.398	.2377
12.1	.0066	0.396	0.429	.3801		12.1	-0.0063	0.405	0.403	.2486
15.0	.0077	0.496	0.420	.3989		15.0	-0.0087	0.521	0.406	.2605
18.0	.0091	0.606	0.408	.4331		18.1	-0.0113	0.649	0.410	.2695
$M = 1.00$										
-02.7	-0.0045	-0.080	0.719	.5214		-02.3	-0.0011	-0.082	0.337	.1931
-00.7	-0.0031	-0.023	0.717	.5250		-00.2	-0.0018	-0.024	0.355	.1980
00.2	-0.0036	0.012	0.719	.5258		00.7	-0.0009	0.009	0.350	.2042
03.1	-0.0010	0.102	0.711	.5212		03.6	-0.0011	0.100	0.336	.2001
06.2	-0.0008	0.196	0.700	.5236		06.7	-0.0016	0.201	0.336	.1952
09.2	.0021	0.293	0.705	.5305		09.8	-0.0035	0.306	0.339	.1958
12.2	.0033	0.392	0.700	.5562		12.7	-0.0062	0.413	0.343	.1999
15.2	.0042	0.494	0.701	.5886		15.6	-0.0095	0.532	0.345	.2034
18.2	.0040	0.601	0.696	.6179		18.7	-0.0145	0.672	0.354	.2074
$M = 1.10$										
-02.6	-0.0046	-0.078	0.720	.3897						
-00.7	-0.0038	-0.027	0.720	.3919						
00.3	-0.0036	0.005	0.716	.3994						
03.2	.0007	0.092	0.713	.3942						
06.2	-0.0012	0.184	0.708	.3887						
09.3	.0003	0.276	0.705	.3935						
12.3	.0003	0.368	0.702	.4055						
15.2	.0003	0.466	0.701	.4481						
18.3	.0001	0.566	0.697	.4802						

TABLE II.- STATIC STABILITY DATA - Continued

(b) Sharp cone with spherical base; center of moments at  $0.677d$  from model base,  
center of spherical base at  $0.677d$

$\alpha$	$C_m$	$C_N$	$C_A$	$C_{P_b}$	$\alpha$	$C_m$	$C_N$	$C_A$	$C_{P_b}$
$M = 0.25$									
-02.9	.0095	-0.127	0.321	.3465	-02.8	.0009	-0.097	0.611	.3845
-01.0	.0052	-0.068	0.326	.3465	-00.7	.0000	-0.033	0.616	.3889
00.0	.0097	-0.048	0.335	.3465	00.2	.0007	0.001	0.615	.3959
02.9	.0198	0.055	0.340	.3426	03.2	.0038	0.099	0.609	.3833
05.9	.0247	0.144	0.330	.3504	06.2	.0028	0.199	0.624	.3969
09.0	.0438	0.223	0.333	.3585	09.2	.0031	0.298	0.635	.4223
12.0	.0556	0.296	0.337	.3662	12.2	.0043	0.395	0.641	.4353
15.0	.0672	0.380	0.335	.3898	15.1	.0068	0.494	0.644	.4554
18.0	.0925	0.461	0.338	.4182	18.2	.0082	0.604	0.650	.4840
$M = 0.65$									
-03.0	-.0071	-0.091	0.362	.3627	-02.9	-.0011	-0.099	0.576	.3566
-01.0	-.0033	-0.033	0.364	.3581	-00.8	.0009	-0.035	0.581	.3684
00.0	-.0021	-0.003	0.365	.3552	00.1	.0009	-0.003	0.581	.3720
02.9	.0063	0.084	0.367	.3591	03.1	-.0011	0.098	0.574	.3581
05.9	.0121	0.175	0.365	.3652	06.1	-.0044	0.202	0.586	.3700
08.9	.0182	0.265	0.365	.3718	09.2	-.0065	0.306	0.598	.3920
11.9	.0269	0.350	0.361	.3912	12.1	-.0069	0.406	0.603	.4013
15.0	.0345	0.435	0.357	.4102	15.1	-.0053	0.512	0.610	.4235
17.8	.0476	0.509	0.347	.4263	18.1	-.0039	0.628	0.620	.4491
$M = 0.80$									
-03.1	-.0023	-0.097	0.395	.3637	-02.9	.0070	-0.112	0.465	.2936
-01.0	.0009	-0.034	0.395	.3629	-01.0	.0061	-0.049	0.473	.2970
00.0	.0007	-0.002	0.397	.3552	00.0	.0074	-0.019	0.477	.3054
03.0	.0043	0.093	0.400	.3629	03.0	.0068	0.081	0.466	.2936
05.8	.0068	0.189	0.395	.3622	05.9	.0048	0.178	0.470	.2900
08.9	.0118	0.284	0.391	.3708	09.0	.0029	0.281	0.478	.2995
12.0	.0173	0.375	0.389	.3992	12.0	.0005	0.389	0.483	.3125
14.9	.0241	0.468	0.383	.4190	15.0	-.0023	0.501	0.492	.3315
17.8	.0326	0.555	0.374	.4441	18.1	-.0076	0.628	0.505	.3493
$M = 0.90$									
-02.9	-.0024	-0.090	0.446	.3648	-02.9	.0012	-0.091	0.393	.2364
-00.7	-.0010	-0.027	0.444	.3657	-00.8	.0016	-0.030	0.406	.2434
00.2	.0007	0.010	0.442	.3608	00.1	.0014	-0.001	0.408	.2507
03.1	.0026	0.097	0.448	.3625	03.1	.0012	0.097	0.396	.2448
06.1	.0043	0.195	0.444	.3673	06.0	.0001	0.192	0.399	.2347
09.1	.0069	0.293	0.444	.3824	09.0	-.0029	0.298	0.403	.2413
12.0	.0095	0.387	0.442	.3995	12.1	-.0050	0.407	0.410	.2531
15.2	.0145	0.485	0.435	.4244	15.1	-.0085	0.524	0.418	.2599
18.0	.0183	0.584	0.420	.4477	18.1	-.0105	0.650	0.432	.2697
$M = 1.00$									
-02.7	-.0053	-0.080	0.720	.5453	-02.3	.0103	-0.088	0.334	.1993
-00.7	-.0038	-0.023	0.725	.5353	-00.2	-.0022	-0.015	0.345	.2073
00.3	-.0032	0.016	0.726	.5386	00.6	-.0015	0.009	0.346	.2121
03.2	.0060	0.098	0.724	.5211	03.7	-.0018	0.105	0.331	.2025
06.1	.0078	0.191	0.721	.5352	06.7	-.0056	0.206	0.334	.1946
09.2	.0077	0.290	0.719	.5548	09.8	-.0097	0.310	0.339	.1919
12.2	.0085	0.387	0.715	.5683	12.7	-.0133	0.421	0.349	.2003
15.2	.0073	0.486	0.707	.5887	15.7	-.0165	0.540	0.361	.2051
18.2	.0076	0.593	0.701	.6218	18.6	-.0210	0.667	0.369	.2108
$M = 1.10$									
-02.7	-.0058	-0.080	0.725	.4035					
-00.6	-.0046	-0.024	0.722	.3840					
00.2	-.0049	0.005	0.722	.4023					
03.2	.0053	0.087	0.720	.3752					
06.3	.0051	0.180	0.722	.3986					
09.2	.0052	0.270	0.721	.4142					
12.3	.0046	0.363	0.718	.4305					
15.2	.0045	0.459	0.710	.4524					
18.3	.0034	0.558	0.702	.4738					
$M = 1.20$									
-02.8	.0009	-0.097	0.611	.3845					
-00.7	.0000	-0.033	0.616	.3889					
00.2	.0007	0.001	0.615	.3959					
03.2	.0038	0.099	0.609	.3833					
06.2	.0028	0.199	0.624	.3969					
09.2	.0031	0.298	0.635	.4223					
12.2	.0043	0.395	0.641	.4353					
15.1	.0068	0.494	0.644	.4554					
18.1	.0082	0.604	0.650	.4840					
$M = 1.30$									
-02.9	-.0011	-0.099	0.576	.3566					
-00.8	.0009	-0.035	0.581	.3684					
00.1	.0009	-0.003	0.581	.3720					
03.1	-.0011	0.098	0.574	.3581					
06.1	-.0044	0.202	0.586	.3700					
09.2	-.0065	0.306	0.598	.3920					
12.1	-.0069	0.406	0.603	.4013					
15.1	-.0053	0.512	0.610	.4235					
18.1	-.0039	0.628	0.620	.4491					
$M = 1.40$									
-02.9	-.0011	-0.099	0.576	.3566					
-00.8	.0009	-0.035	0.581	.3684					
00.1	.0009	-0.003	0.581	.3720					
03.1	-.0011	0.098	0.574	.3581					
06.1	-.0044	0.202	0.586	.3700					
09.2	-.0065	0.306	0.598	.3920					
12.1	-.0069	0.406	0.603	.4013					
15.1	-.0053	0.512	0.610	.4235					
18.1	-.0039	0.628	0.620	.4491					
$M = 1.60$									
-02.9	.0070	-0.112	0.465	.2936					
-01.0	.0061	-0.049	0.473	.2970					
00.0	.0074	-0.019	0.477	.3054					
03.0	.0068	0.081	0.466	.2936					
05.9	.0048	0.178	0.470	.2900					
08.9	.0029	0.281	0.478	.2995					
12.0	.0005	0.389	0.483	.3125					
15.0	-.0023	0.501	0.492	.3315					
18.0	-.0076	0.628	0.505	.3493					
$M = 1.80$									
-02.9	-.0012	-0.091	0.393	.2364					
-00.8	.0016	-0.030	0.406	.2434					
00.1	.0014	-0.001	0.408	.2507					
03.1	.0012	0.097	0.396	.2448					
06.1	.0001	0.192	0.399	.2347					
09.0	-.0029	0.298	0.403	.2413					
12.0	-.0050	0.407	0.410	.2531					
15.1	-.0085	0.524	0.418	.2599					
18.1	-.0105	0.650	0.432	.2697					
$M = 2.00$									
-02.7	-.0053	-0.080	0.720	.5453					
-00.7	-.0038	-0.023	0.725	.5353					
00.3	-.0032	0.016	0.726	.5386					
03.2	.0060	0.098	0.724	.5211					
06.1	.0078	0.191	0.721	.5352					
09.2	.0077	0.290	0.719	.5548					
12.2	.0085	0.387	0.715	.5683					
15.2	.0073	0.486	0.707	.5887					
18.2	.0076	0.593	0.701	.6218					
$M = 2.20$									
-02.3	.0103	-0.088	0.334	.1993					
-00.2	-.0022	-0.015	0.345	.2073					
00.6	-.0015	0.009	0.346	.2121					
03.7	-.0018	0.105	0.331	.2025					
06.7	-.0056	0.206	0.334	.1946					
09.8	-.0097	0.310	0.339	.1919					
12.7	-.0133	0.421	0.349	.2003					
15.7	-.0165	0.540	0.361	.2051					
18.6	-.0210	0.667	0.369	.2108					
$M = 2.40$									
-02.7	-.0058	-0.080	0.725	.4035					
-00.6	-.0046	-0.024	0.722	.3840					

TABLE II.- STATIC STABILITY DATA - Continued

(c) Blunt cone with flat base; center of moments at 0.445d from model base

$\alpha$	$C_m$	$C_N$	$C_A$	$C_{p_b}$		$\alpha$	$C_m$	$C_N$	$C_A$	$C_{p_b}$
$M = 0.25$										
-03.0	-0.0175	-0.100	0.299	•3346		-02.8	-0.0085	-0.096	0.658	•3747
-01.0	-0.0168	-0.041	0.318	•3189		-00.8	-0.0045	-0.028	0.656	•3739
00.0	-0.0084	-0.021	0.315	•3308		00.2	-0.0004	0.007	0.655	•3735
02.0	-0.0083	0.073	0.317	•3308		03.1	-0.0077	0.110	0.657	•3756
05.9	0.0166	0.145	0.315	•3504		06.2	0.0141	0.219	0.669	•3886
09.0	0.0266	0.232	0.312	•3387		09.2	0.0203	0.332	0.687	•4110
12.0	0.0410	0.307	0.303	•3504		12.2	0.0255	0.436	0.700	•4358
15.0	0.0556	0.382	0.309	•3854		15.2	0.0280	0.543	0.718	•4658
17.9	0.0745	0.446	0.302	•4157		18.2	0.0282	0.657	0.740	•5032
$M = 0.65$										
-03.0	-0.0103	-0.090	0.371	•3419		-02.8	-0.0056	-0.100	0.651	•3491
-01.0	-0.0049	-0.033	0.367	•3417		-00.7	-0.0037	-0.032	0.648	•3496
00.0	-0.0026	-0.003	0.367	•3425		00.1	-0.0015	0.003	0.648	•3486
02.0	-0.0053	0.086	0.365	•3412		02.8	0.0013	0.105	0.650	•3485
05.9	0.0160	0.170	0.359	•3483		06.0	0.0054	0.218	0.663	•3612
08.0	0.0259	0.257	0.354	•3494		09.2	0.0067	0.334	0.682	•3846
11.9	0.0370	0.343	0.353	•3676		12.1	0.0097	0.442	0.698	•4067
14.9	0.0447	0.420	0.349	•3939		15.1	0.0128	0.548	0.716	•4276
17.9	0.0552	0.503	0.342	•4218		18.2	0.0131	0.660	0.744	•4697
$M = 0.80$										
-03.0	-0.0097	-0.092	0.393	•3473		-02.9	-0.0007	-0.104	0.611	•2909
-01.0	-0.0044	-0.031	0.397	•3443		-01.0	-0.0008	-0.045	0.612	•2861
-00.1	-0.0026	-0.000	0.397	•3451		00.0	-0.0006	-0.011	0.613	•2873
02.0	-0.0072	0.094	0.394	•3499		02.9	-0.0015	0.087	0.612	•2873
05.9	0.0173	0.189	0.390	•3485		05.9	-0.0000	0.190	0.618	•2919
08.0	0.0256	0.285	0.389	•3592		09.0	-0.0003	0.292	0.630	•3004
11.9	0.0360	0.376	0.389	•3804		12.0	-0.0020	0.392	0.641	•3133
14.9	0.0459	0.469	0.386	•4056		14.9	-0.0038	0.493	0.658	•3321
18.0	0.0567	0.563	0.384	•4374		17.9	-0.0076	0.601	0.676	•3511
$M = 0.90$										
-02.9	-0.0079	-0.089	0.441	•3490		-02.8	-0.0011	-0.080	0.572	•2346
-00.8	-0.0043	-0.024	0.446	•3435		-00.8	-0.0014	-0.024	0.574	•2342
00.1	-0.0006	0.008	0.447	•3511		00.1	-0.0012	-0.007	0.574	•2312
02.0	-0.0072	0.103	0.448	•3540		03.0	-0.0026	0.095	0.576	•2382
06.1	0.0163	0.202	0.450	•3630		06.0	-0.0044	0.191	0.579	•2404
09.1	0.0261	0.301	0.456	•3689		09.0	-0.0048	0.282	0.583	•2435
12.1	0.0360	0.401	0.452	•3905		12.1	-0.0064	0.374	0.592	•2487
15.1	0.0426	0.505	0.444	•4123		15.1	-0.0083	0.470	0.604	•2621
18.1	0.0492	0.610	0.426	•4443		18.1	-0.0109	0.565	0.618	•2704
$M = 1.00$										
-02.7	-0.0110	-0.078	0.718	•5068		-02.3	-0.0003	-0.068	0.546	•1881
-00.7	-0.0049	-0.019	0.723	•5164		-00.2	-0.0017	-0.015	0.548	•1938
00.2	-0.0005	0.013	0.721	•4968		00.6	-0.0004	0.011	0.549	•1976
03.2	-0.0094	0.106	0.719	•5192		03.7	-0.0022	0.094	0.543	•1986
06.2	0.0200	0.199	0.715	•5300		06.7	-0.0041	0.182	0.540	•2002
09.2	0.0336	0.293	0.721	•5360		09.7	-0.0050	0.268	0.543	•1971
12.2	0.0463	0.392	0.716	•5570		12.7	-0.0063	0.353	0.551	•1985
15.2	0.0508	0.509	0.706	•5874		15.7	-0.0090	0.444	0.565	•2024
18.3	0.0490	0.644	0.704	•6212		18.7	-0.0117	0.534	0.575	•2088
$M = 1.10$										
-02.7	-0.0104	-0.080	0.719	•3773						
-00.7	-0.0046	-0.023	0.716	•3805						
00.3	-0.0014	0.010	0.718	•3773						
03.1	-0.0074	0.092	0.715	•3718						
06.2	0.0184	0.183	0.716	•3819						
09.2	0.0299	0.272	0.718	•3875						
12.3	0.0427	0.367	0.711	•4084						
15.2	0.0513	0.470	0.709	•4452						
18.3	0.0445	0.601	0.718	•4973						

TABLE II.- STATIC STABILITY DATA - Continued

(d) Blunt cone with spherical base; center of moments at  $0.445d$  from model base,  
center of spherical base at  $0.562d$

$\alpha$	$C_m$	$C_N$	$C_A$	$C_{p_b}$		$\alpha$	$C_m$	$C_N$	$C_A$	$C_{p_b}$
$M = 0.25$										
-02.9	-0.0031	-0.120	0.304	.3580		-02.7	-0.0078	-0.099	0.662	.3842
-01.0	-0.0071	-0.061	0.316	.3308		-00.8	-0.0030	-0.032	0.657	.3794
00.0	-0.0100	-0.035	0.323	.3426		00.3	-0.006	0.005	0.654	.3785
02.9	.0165	0.049	0.336	.3426		03.2	.0080	0.114	0.661	.3854
06.0	.0265	0.115	0.339	.4088		06.2	.0140	0.222	0.676	.4011
08.9	.0225	0.230	0.321	.3695		09.2	.0199	0.332	0.693	.4223
12.0	.0319	0.328	0.319	.3811		15.1	.0271	0.550	0.723	.4743
15.0	.0385	0.422	0.327	.4205		18.2	.0259	0.662	0.737	.5023
17.9	.0331	0.528	0.339	.4438		12.1	.0237	0.441	0.705	.4442
$M = 0.65$										
-03.1	-0.0103	-0.088	0.364	.3562		-02.9	-0.0051	-0.106	0.657	.3623
-01.0	-0.0041	-0.035	0.367	.3522		-00.8	-0.0030	-0.036	0.652	.3588
00.0	-0.0019	-0.007	0.368	.3545		00.1	-0.0011	0.001	0.651	.3543
02.9	.0070	0.083	0.369	.3545		03.1	.0019	0.111	0.658	.3602
05.9	.0175	0.170	0.366	.3681		06.0	.0042	0.222	0.671	.3715
08.9	.0267	0.261	0.365	.3847		09.2	.0059	0.336	0.688	.3891
11.9	.0341	0.348	0.363	.4067		12.2	.0082	0.446	0.699	.4090
14.9	.0421	0.434	0.357	.4272		15.1	.0113	0.553	0.716	.4300
17.9	.0483	0.519	0.353	.4521		18.1	.0106	0.667	0.741	.4665
$M = 0.80$										
-03.0	-0.0096	-0.090	0.394	.3612		-02.9	.0013	-0.108	0.612	.2881
-01.0	-0.0046	-0.033	0.399	.3576		-00.9	.0017	-0.048	0.616	.2931
00.0	-0.0011	-0.002	0.399	.3581		00.0	.0015	-0.013	0.617	.2931
02.9	.0079	0.093	0.397	.3594		02.9	.0022	0.084	0.614	.2943
05.9	.0167	0.190	0.396	.3684		05.9	.0016	0.186	0.623	.2981
08.9	.0261	0.287	0.396	.3869		09.0	.0004	0.289	0.629	.3100
12.0	.0339	0.387	0.401	.4043		12.0	-.0023	0.391	0.639	.3230
14.9	.0429	0.479	0.394	.4356		15.0	-.0046	0.494	0.654	.3359
17.9	.0509	0.578	0.392	.4560		18.0	-.0094	0.605	0.671	.3537
$M = 0.90$										
-02.9	-0.0095	-0.088	0.446	.3602		-02.9	.0008	-0.082	0.575	.2352
-00.8	-0.0030	-0.026	0.445	.3577		-00.8	-.0015	-0.025	0.576	.2396
00.1	.0001	0.006	0.444	.3472		00.1	.0005	0.001	0.578	.2403
02.9	.0065	0.097	0.450	.3631		03.1	-.0021	0.095	0.579	.2429
06.1	.0160	0.204	0.455	.3809		06.1	-.0040	0.187	0.578	.2415
09.1	.0258	0.303	0.456	.4017		09.1	-.0047	0.281	0.581	.2473
12.1	.0342	0.405	0.457	.4214		12.1	-.0069	0.376	0.590	.2508
15.1	.0414	0.512	0.451	.4362		15.1	-.0108	0.474	0.601	.2576
18.1	.0465	0.622	0.435	.4645		18.2	-.0133	0.571	0.615	.2739
$M = 1.00$										
-02.7	-0.0099	-0.079	0.713	.5191		-02.2	.0001	-0.068	0.540	.1949
-00.7	-0.0039	-0.022	0.713	.5232		-00.2	.0004	-0.017	0.542	.1976
00.3	.0005	0.014	0.712	.5199		00.8	.0009	0.014	0.543	.2007
03.1	.0095	0.102	0.703	.5199		03.6	-.0017	0.093	0.538	.1992
06.2	.0210	0.200	0.725	.5482		06.7	-.0035	0.180	0.538	.1971
09.2	.0334	0.296	0.724	.5637		09.7	-.0053	0.269	0.539	.1976
12.3	.0430	0.400	0.716	.5771		12.7	-.0078	0.356	0.547	.1976
15.3	.0478	0.523	0.709	.6151		15.7	-.0102	0.445	0.558	.1992
18.2	.0449	0.654	0.707	.6380		18.7	-.0146	0.541	0.571	.2056
$M = 1.10$										
-02.8	-0.0111	-0.079	0.717	.3823						
-00.7	-0.0041	-0.025	0.698	.3715						
00.3	.0005	0.007	0.715	.3757						
03.2	.0086	0.093	0.713	.3897						
06.2	.0177	0.186	0.721	.4062						
09.3	.0304	0.280	0.717	.4296						
12.3	.0405	0.370	0.716	.4368						
15.2	.0487	0.479	0.712	.4672						
18.2	.0416	0.607	0.715	.4968						

TABLE II.- STATIC STABILITY DATA - Continued

(e) Blunt cone with spherical base; center of moments at 0.445d from model base,  
center of spherical base at 0.445d

$\alpha$	$C_m$	$C_N$	$C_A$	$C_{P_b}$		$\alpha$	$C_m$	$C_N$	$C_A$	$C_{P_b}$
$M = 0.25$										
-02.9	-0.0114	-0.090	0.343	.3308		-02.6	-0.0082	-0.097	0.667	.3851
-01.0	-0.0056	-0.048	0.344	.3346		-00.7	-0.0026	-0.028	0.659	.3800
00.0	-0.0032	-0.028	0.350	.3346		00.2	.0018	0.005	0.657	.3802
02.9	.0181	0.062	0.346	.3346		03.3	.0087	0.115	0.664	.3818
05.9	.0169	0.134	0.365	.3943		09.2	.0208	0.330	0.695	.4175
09.0	.0239	0.246	0.339	.3585		12.2	.0244	0.437	0.707	.4378
12.0	.0317	0.330	0.337	.3869		15.2	.0260	0.551	0.723	.4667
15.0	.0382	0.423	0.337	.4110		18.2	.0256	0.660	0.738	.4992
17.9	.0421	0.512	0.344	.4473						
$M = 1.20$										
-02.9	-0.0101	-0.087	0.374	.3561		-02.9	-0.0054	-0.103	0.662	.3620
-01.0	-0.0039	-0.034	0.376	.3577		-00.7	-0.0032	-0.033	0.657	.3569
00.0	.0004	-0.006	0.376	.3584		00.1	-0.0011	0.001	0.656	.3548
02.9	.0091	0.281	0.376	.3616		03.0	.0028	0.108	0.660	.3571
05.9	.0174	0.169	0.371	.3668		06.1	.0046	0.221	0.673	.3700
09.0	.0268	0.261	0.374	.3788		09.2	.0062	0.334	0.692	.3864
11.9	.0356	0.341	0.373	.4015		12.0	.0085	0.443	0.700	.4048
14.9	.0430	0.432	0.364	.4219		15.1	.0111	0.552	0.716	.4285
17.9	.0507	0.510	0.358	.4536		18.1	.0100	0.663	0.739	.4602
$M = 1.30$										
-02.9	-0.0101	-0.087	0.374	.3561		-02.9	-0.0054	-0.103	0.662	.3620
-01.0	-0.0039	-0.034	0.376	.3577		-00.7	-0.0032	-0.033	0.657	.3569
00.0	.0004	-0.006	0.376	.3584		00.1	-0.0011	0.001	0.656	.3548
02.9	.0091	0.281	0.376	.3616		03.0	.0028	0.108	0.660	.3571
05.9	.0174	0.169	0.371	.3668		06.1	.0046	0.221	0.673	.3700
09.0	.0268	0.261	0.374	.3788		09.2	.0062	0.334	0.692	.3864
11.9	.0356	0.341	0.373	.4015		12.0	.0085	0.443	0.700	.4048
14.9	.0430	0.432	0.364	.4219		15.1	.0111	0.552	0.716	.4285
17.9	.0507	0.510	0.358	.4536		18.1	.0100	0.663	0.739	.4602
$M = 1.60$										
-03.0	-0.0088	-0.090	0.405	.3615		-02.9	.0020	-0.108	0.615	.2899
-01.0	-0.0036	-0.032	0.406	.3581		-01.0	.0018	-0.047	0.619	.2900
00.0	.0002	-0.002	0.407	.3564		00.0	.0015	-0.013	0.618	.2912
02.9	.0101	0.090	0.402	.3616		02.9	.0018	0.085	0.616	.2926
05.9	.0184	0.190	0.403	.3634		05.9	.0016	0.187	0.624	.2950
08.9	.0266	0.284	0.401	.3804		09.0	.0001	0.287	0.628	.3046
11.9	.0348	0.380	0.400	.4013		12.0	-0.0023	0.391	0.641	.3151
14.9	.0421	0.479	0.400	.4285		15.0	-0.0055	0.493	0.653	.3281
17.9	.0505	0.569	0.393	.4504		17.9	-0.0088	0.595	0.666	.3412
$M = 1.90$										
-02.8	-0.0092	-0.086	0.453	.3604		-02.8	-0.0012	-0.080	0.580	.2374
-00.8	-0.0036	-0.024	0.455	.3591		-00.8	.0003	-0.026	0.581	.2374
00.1	.0005	0.009	0.454	.3558		00.1	.0007	0.006	0.582	.2404
03.1	.0099	0.101	0.453	.3558		03.1	-0.0015	0.094	0.583	.2424
06.0	.0172	0.202	0.453	.3697		06.1	-0.0034	0.187	0.582	.2427
09.1	.0264	0.302	0.460	.3887		09.0	-0.0048	0.280	0.581	.2432
12.1	.0339	0.402	0.452	.4166		12.1	-0.0064	0.375	0.591	.2497
15.0	.0413	0.505	0.450	.4338		15.0	-0.0097	0.467	0.600	.2513
18.1	.0469	0.621	0.439	.4593		18.1	-0.0133	0.566	0.616	.2610
$M = 2.20$										
-02.7	-0.0103	-0.077	0.723	.5182		-02.1	.0007	-0.070	0.544	.1913
-00.7	-0.0031	-0.021	0.720	.5069		-00.1	.0006	-0.012	0.545	.1929
00.2	.0007	0.012	0.719	.5123		00.8	.0008	0.014	0.545	.1977
03.2	.0106	0.106	0.717	.5182		03.7	.0008	0.094	0.542	.1994
06.2	.0216	0.199	0.723	.5347		06.7	-0.0019	0.180	0.536	.1968
09.2	.0332	0.294	0.726	.5561		09.7	-0.0049	0.267	0.537	.1919
12.2	.0446	0.395	0.721	.5757		12.8	-0.0072	0.354	0.548	.1945
15.2	.0478	0.517	0.707	.5954		15.7	-0.0111	0.445	0.561	.1993
18.2	.0453	0.652	0.709	.6361		18.6	-0.0151	0.535	0.570	.2029
$M = 1.00$										
-02.7	-0.0103	-0.077	0.723	.5182		-02.1	.0007	-0.070	0.544	.1913
-00.7	-0.0031	-0.021	0.720	.5069		-00.1	.0006	-0.012	0.545	.1929
00.2	.0007	0.012	0.719	.5123		00.8	.0008	0.014	0.545	.1977
03.2	.0106	0.106	0.717	.5182		03.7	.0008	0.094	0.542	.1994
06.2	.0216	0.185	0.726	.5365		06.7	-0.0019	0.180	0.536	.1968
09.2	.0301	0.278	0.725	.5474		09.7	-0.0049	0.267	0.537	.1919
12.2	.0419	0.371	0.715	.5422		12.8	-0.0072	0.354	0.548	.1945
15.2	.0464	0.476	0.714	.5432		15.7	-0.0111	0.445	0.561	.1993
18.2	.0408	0.607	0.717	.5470		18.6	-0.0151	0.535	0.570	.2029
$M = 1.10$										
-02.6	-0.0098	-0.079	0.721	.5806		-02.1	.0007	-0.070	0.544	.1913
-00.8	-0.0036	-0.025	0.717	.5875		-00.1	.0006	-0.012	0.545	.1929
00.4	.0003	0.009	0.720	.5668		00.8	.0008	0.014	0.545	.1977
03.2	.0098	0.093	0.717	.5901		03.7	.0008	0.094	0.542	.1994
06.2	.0194	0.185	0.726	.5965		06.7	-0.0019	0.180	0.536	.1968
09.3	.0301	0.278	0.725	.5474		09.7	-0.0049	0.267	0.537	.1919
12.3	.0419	0.371	0.715	.5422		12.8	-0.0072	0.354	0.548	.1945
15.2	.0464	0.476	0.714	.5432		15.7	-0.0111	0.445	0.561	.1993
18.3	.0408	0.607	0.717	.5470		18.6	-0.0151	0.535	0.570	.2029

TABLE II.- STATIC STABILITY DATA - Concluded

(f) Blunt cone with spherical base; center of moments at 0.445d from model base,  
center of spherical base at 0.323d

$\alpha$	$C_m$	$C_N$	$C_A$	$C_{p_b}$	$\alpha$	$C_m$	$C_N$	$C_A$	$C_{p_b}$
M = 0.25									
-02.8	-.0050	-0.139	0.342	.3506	-02.7	-.0061	-0.105	0.669	.3898
-01.0	.0065	-0.102	0.340	.3385	-00.7	-.0016	-0.035	0.661	.3813
00.0	.0090	-0.082	0.347	.3385	00.2	.0012	0.000	0.659	.3777
02.9	.0167	0.002	0.341	.3426	03.2	.0085	0.113	0.667	.3832
06.0	.0331	0.080	0.377	.4371	06.2	.0148	0.220	0.678	.4003
09.0	.0347	0.211	0.341	.3780	09.2	.0202	0.333	0.693	.4219
12.0	.0411	0.305	0.330	.3854	12.2	.0253	0.440	0.708	.4430
15.0	.0453	0.404	0.315	.4182	15.1	.0273	0.549	0.719	.4680
17.9	.0473	0.510	0.396	.4421	18.2	.0261	0.666	0.739	.5045
M = 0.65									
-03.0	-.0078	-0.095	0.372	.3613	-02.9	-.0052	-0.106	0.663	.3597
-01.0	-.0025	-0.042	0.375	.3591	-00.9	-.0032	-0.038	0.658	.3563
00.0	.0010	-0.012	0.373	.3568	00.1	.0008	-0.002	0.658	.3540
02.9	.0119	0.076	0.374	.3652	03.1	.0032	0.107	0.663	.3598
05.9	.0209	0.162	0.368	.3736	06.1	.0041	0.223	0.675	.3715
08.9	.0289	0.255	0.371	.3855	09.1	.0074	0.336	0.688	.3879
11.9	.0370	0.343	0.369	.4053	12.2	.0099	0.446	0.699	.4043
14.9	.0446	0.431	0.364	.4333	15.1	.0116	0.555	0.716	.4275
17.9	.0510	0.515	0.355	.4585	18.1	.0105	0.669	0.742	.4638
M = 0.80									
-03.0	-.0078	-0.097	0.404	.3646	-03.0	.0024	-0.114	0.617	.2888
-01.0	-.0019	-0.039	0.407	.3625	-01.0	.0016	-0.049	0.620	.2891
00.0	.0010	-0.007	0.409	.3628	00.0	.0018	-0.015	0.622	.2904
02.9	.0105	0.086	0.406	.3694	02.9	.0032	0.082	0.620	.2954
05.9	.0187	0.186	0.404	.3800	05.9	.0025	0.185	0.625	.2977
09.0	.0271	0.284	0.403	.3999	09.0	.0013	0.287	0.629	.3061
11.9	.0350	0.382	0.404	.4158	12.0	-.0016	0.393	0.639	.3179
14.9	.0428	0.482	0.401	.4415	15.0	-.0049	0.496	0.653	.3320
17.9	.0501	0.574	0.392	.4614	17.9	-.0087	0.604	0.670	.3451
M = 0.90									
-02.9	-.0078	-0.093	0.454	.3656	-02.8	-.0005	-0.083	0.585	.2382
-00.8	-.0019	-0.030	0.452	.3611	-00.8	-.0005	-0.028	0.584	.2381
00.1	.0010	0.002	0.454	.3537	00.0	.0001	-0.001	0.588	.2422
03.1	.0090	0.100	0.457	.3758	03.1	.0000	0.090	0.585	.2451
06.1	.0179	0.202	0.462	.3951	06.1	-.0016	0.187	0.582	.2458
09.2	.0264	0.306	0.465	.4030	09.2	-.0039	0.281	0.585	.2450
12.1	.0342	0.405	0.463	.4283	12.1	-.0062	0.377	0.593	.2486
15.1	.0411	0.513	0.459	.4594	15.1	-.0106	0.476	0.604	.2552
18.1	.0471	0.623	0.438	.4698	18.1	-.0134	0.573	0.617	.2642
M = 1.00									
-02.7	-.0096	-0.083	0.727	.5245	-02.2	.0007	-0.070	0.544	.1921
-00.7	-.0026	-0.023	0.718	.5290	-00.1	.0009	-0.020	0.551	.1943
00.3	.0012	0.010	0.716	.5141	00.7	.0011	0.009	0.549	.1985
03.2	.0114	0.101	0.724	.5296	03.7	.0004	0.091	0.544	.1985
06.1	.0212	0.197	0.722	.5620	06.7	-.0016	0.177	0.536	.1979
09.2	.0331	0.297	0.730	.5730	09.8	-.0039	0.267	0.541	.1943
12.2	.0446	0.395	0.717	.5852	12.7	-.0069	0.357	0.549	.1978
15.2	.0476	0.519	0.730	.6305	15.6	-.0108	0.451	0.563	.2010
18.1	.0454	0.654	0.711	.6448	18.7	-.0151	0.546	0.574	.2058
M = 1.10									
-02.6	-.0098	-0.084	0.723	.3981					
-00.7	-.0033	-0.029	0.719	.3838					
00.2	.0003	0.002	0.718	.3904					
03.2	.0097	0.091	0.722	.3868					
06.1	.0189	0.181	0.733	.4141					
09.3	.0304	0.278	0.726	.4301					
12.3	.0415	0.373	0.717	.4440					
15.2	.0498	0.481	0.728	.4894					
18.3	.0413	0.613	0.720	.5051					
M = 1.20									
M = 1.30									
M = 1.40									
M = 1.50									
M = 1.60									
M = 1.70									
M = 1.80									
M = 1.90									
M = 2.00									
M = 2.10									
M = 2.20									

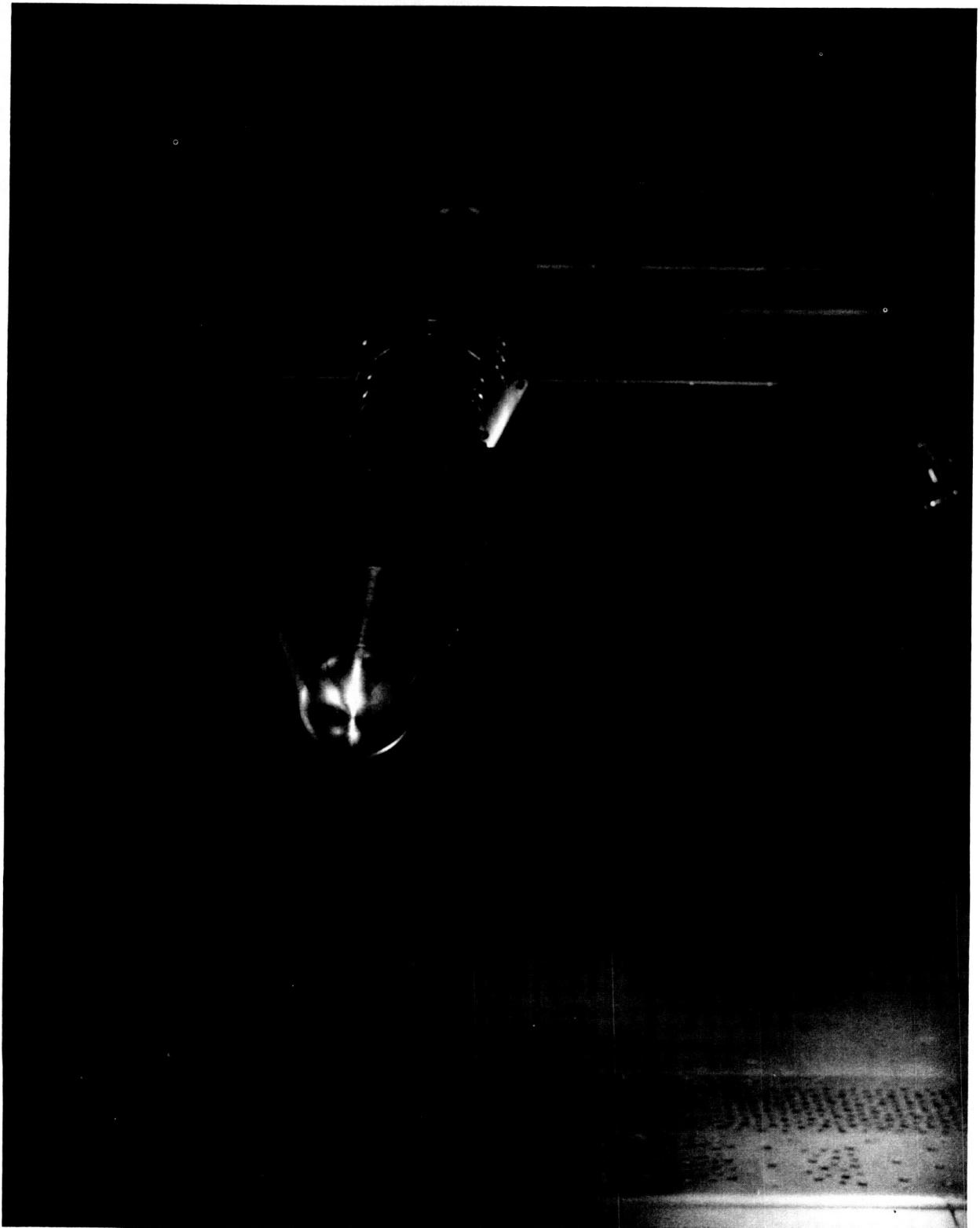
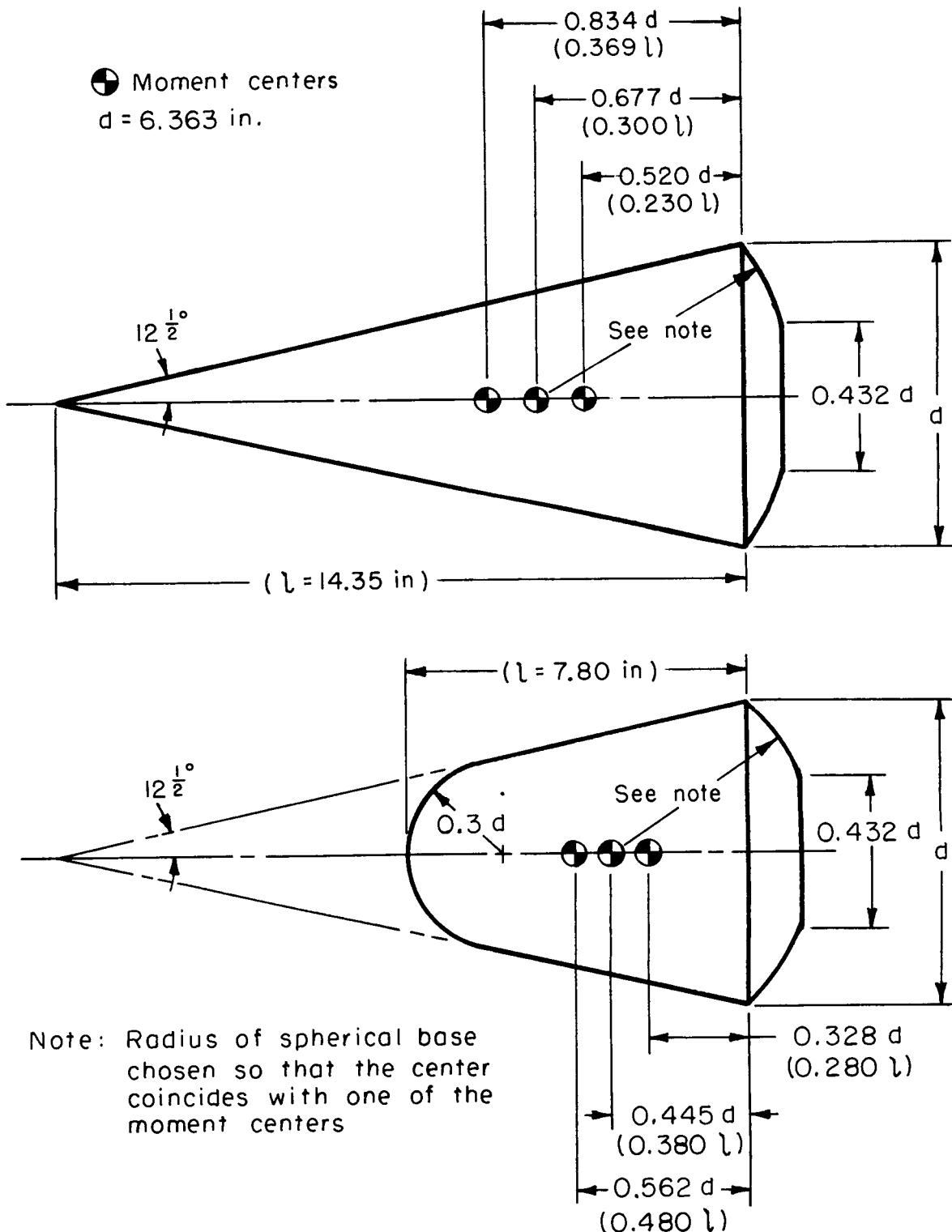


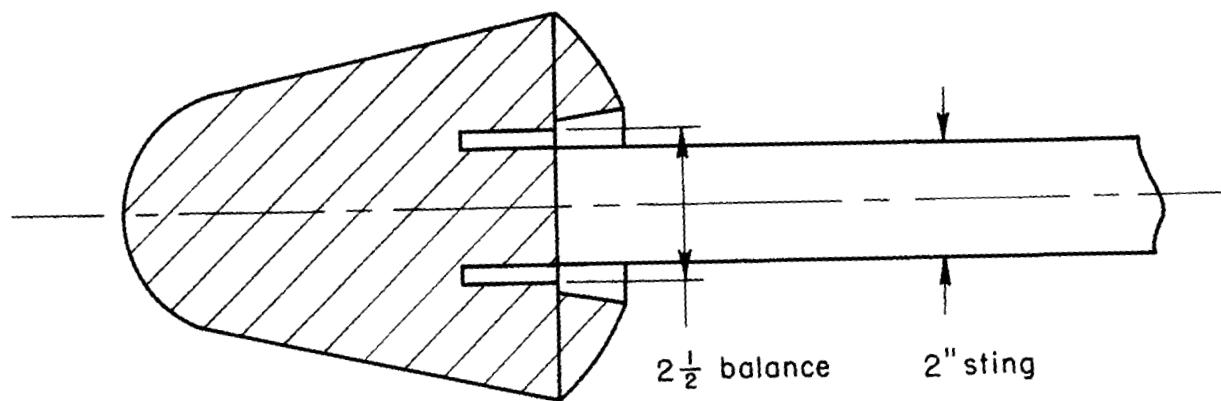
Figure 1.- Photograph of model mounted on dynamic apparatus.

A-27036

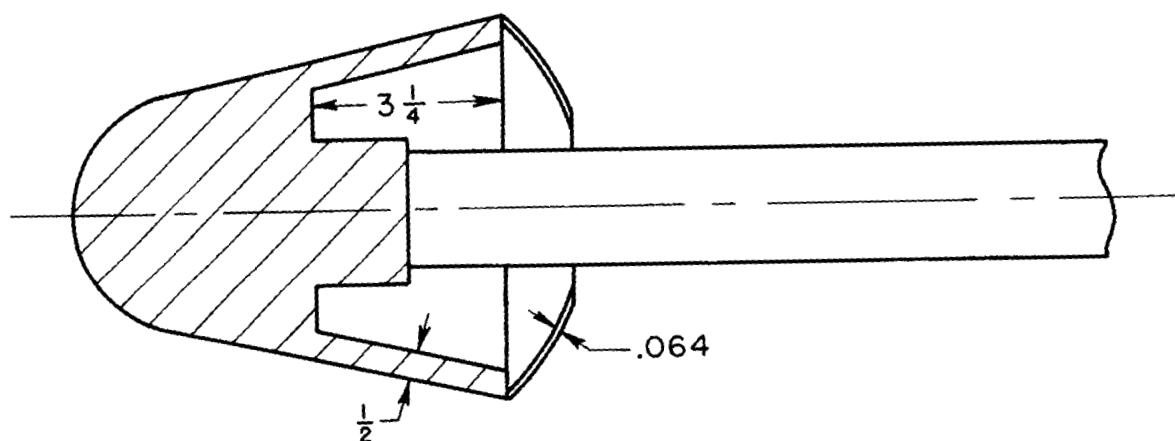


(a) Sketches of models.

Figure 2.- Geometry of the models.



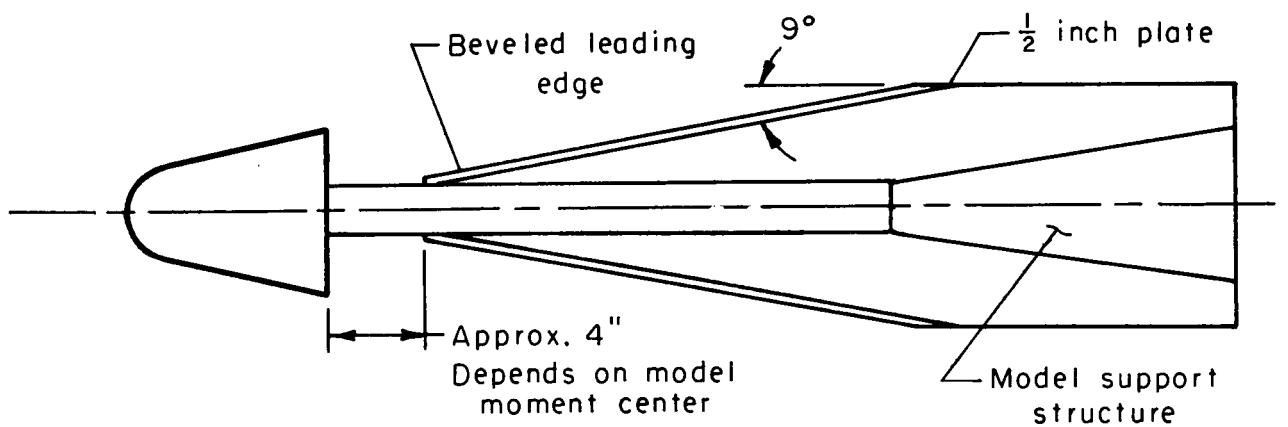
Solid model



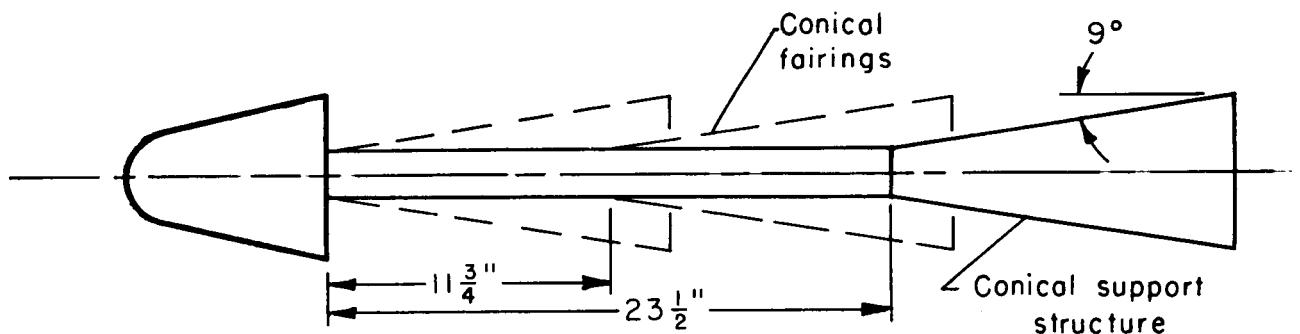
Hollow model

(b) Model interiors.

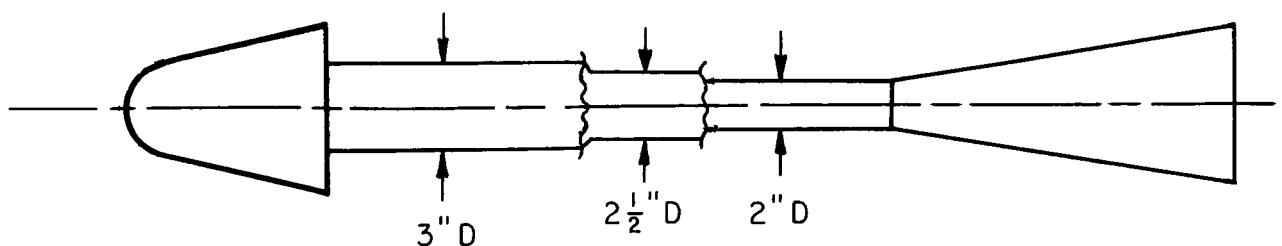
Figure 2.- Continued.



Standard sting setup



Setup for variation of sting length



Setup for variation of sting diameter

(c) Sting modifications.

Figure 2.- Concluded.

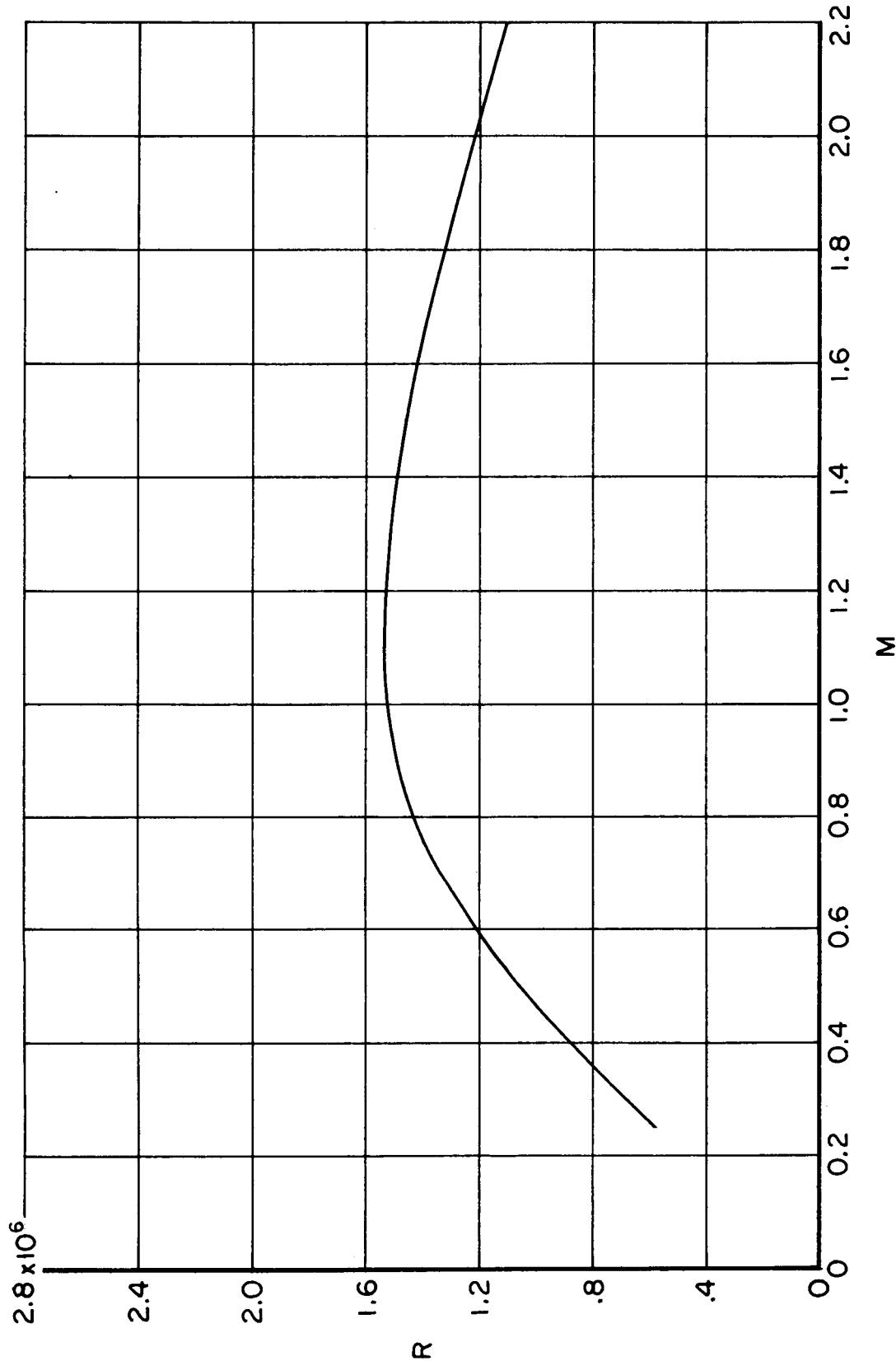
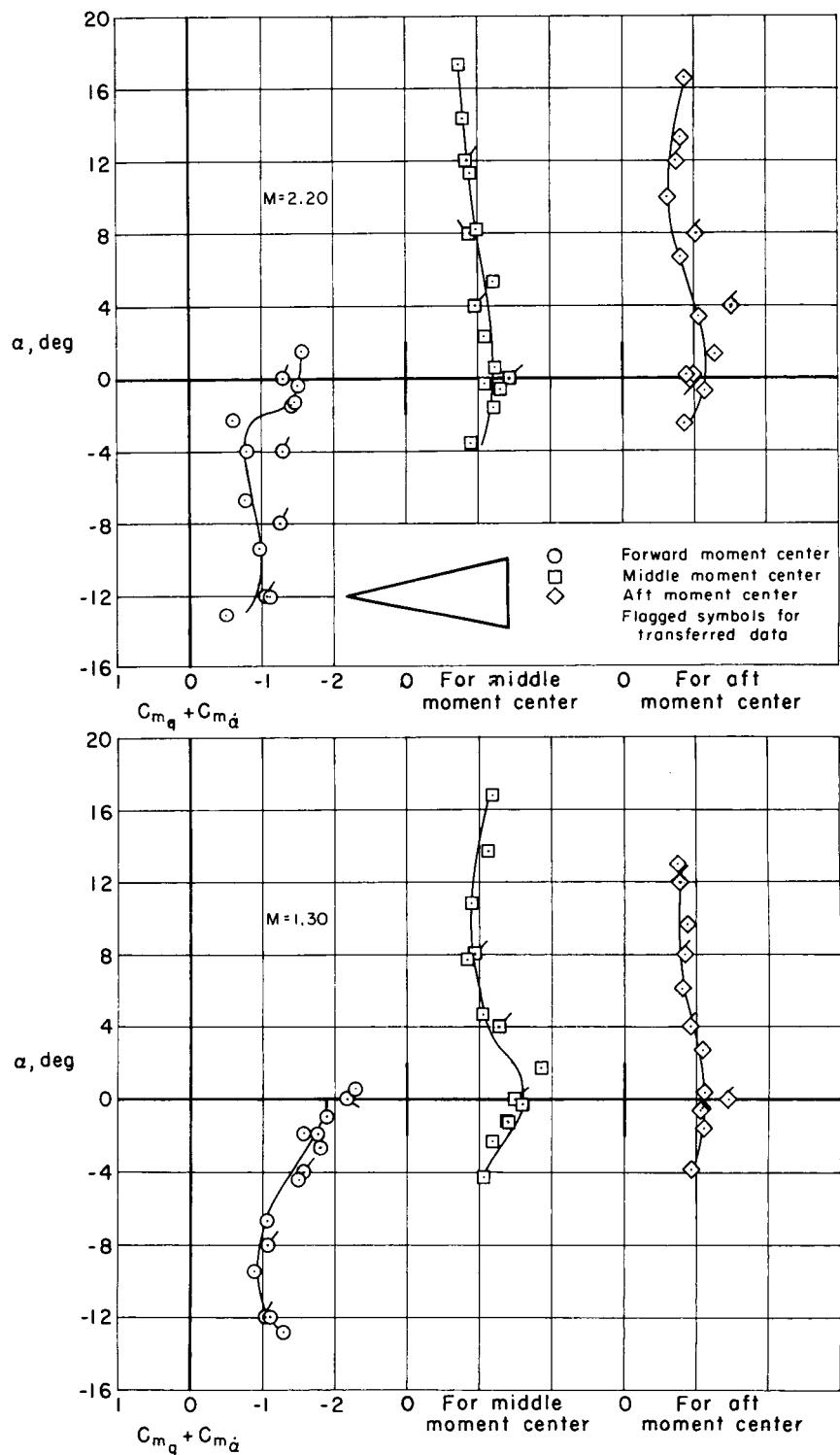
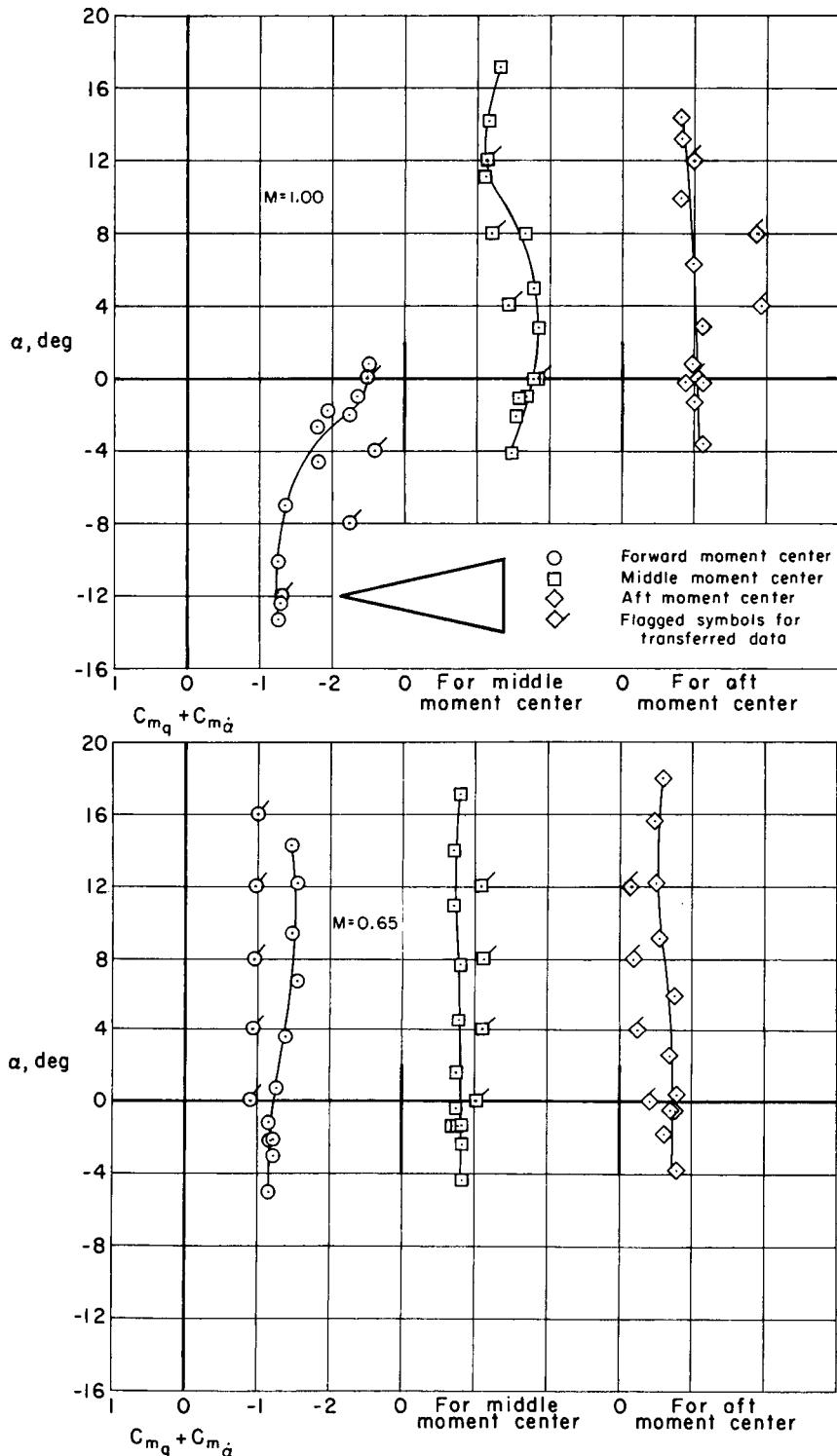


Figure 3.- Variation of test Reynolds number with Mach number.



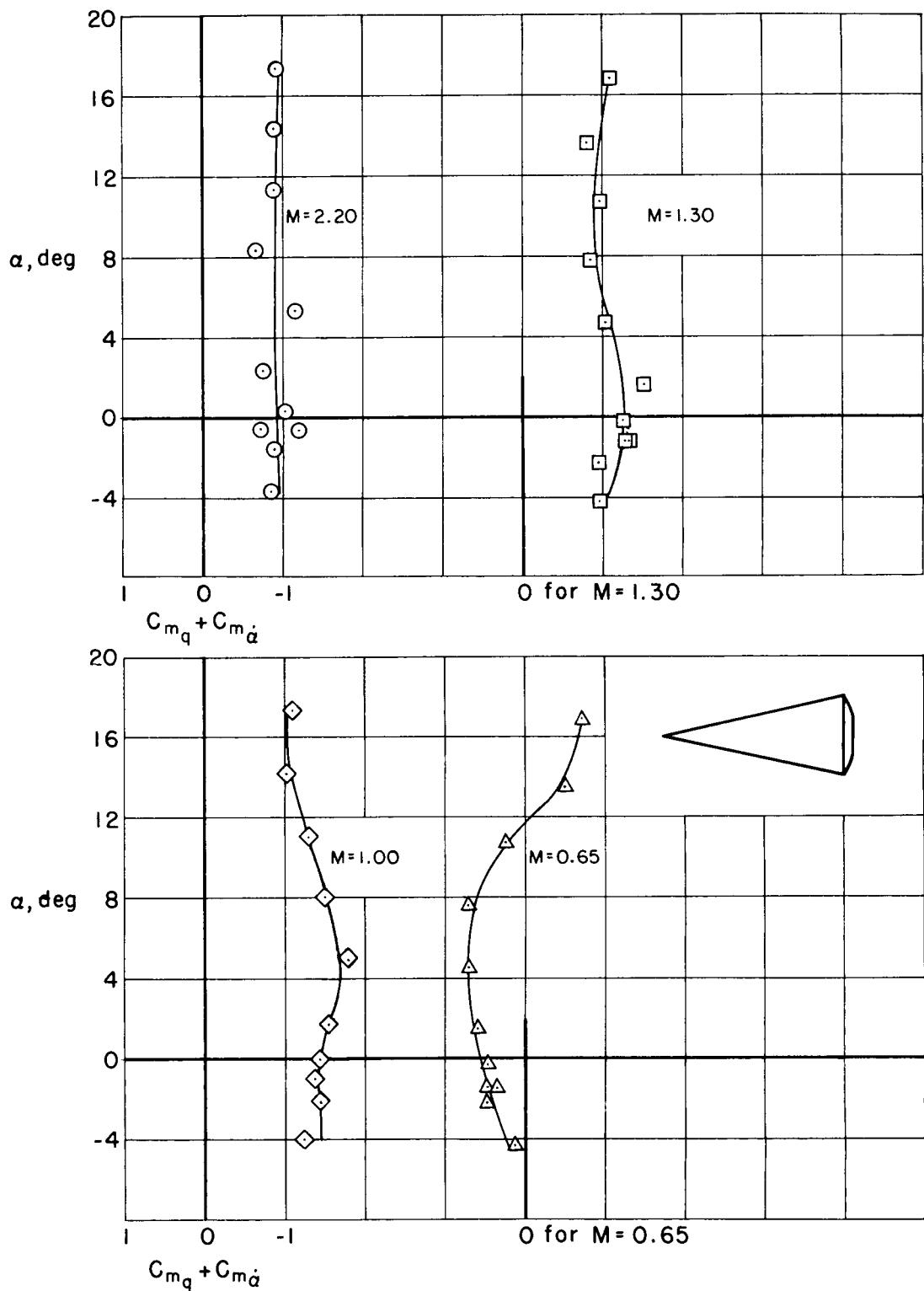
(a) Sharp cone with flat base;  $M = 2.20$  and  $1.30$ .

Figure 4.- Variation of the dynamic stability characteristics with angle of attack.



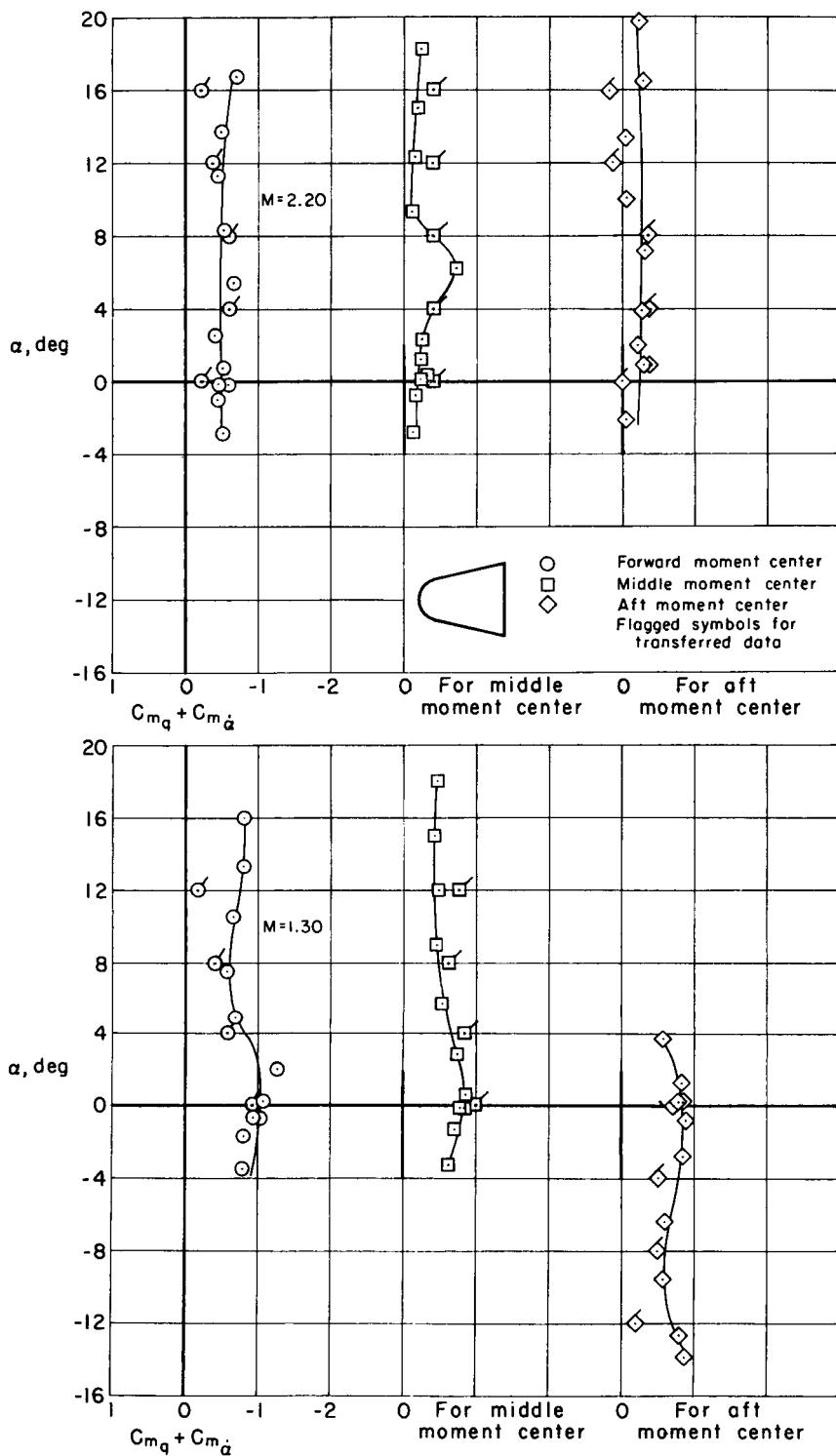
(b) Sharp cone with flat base;  $M = 1.00$  and  $0.65$ .

Figure 4.- Continued.



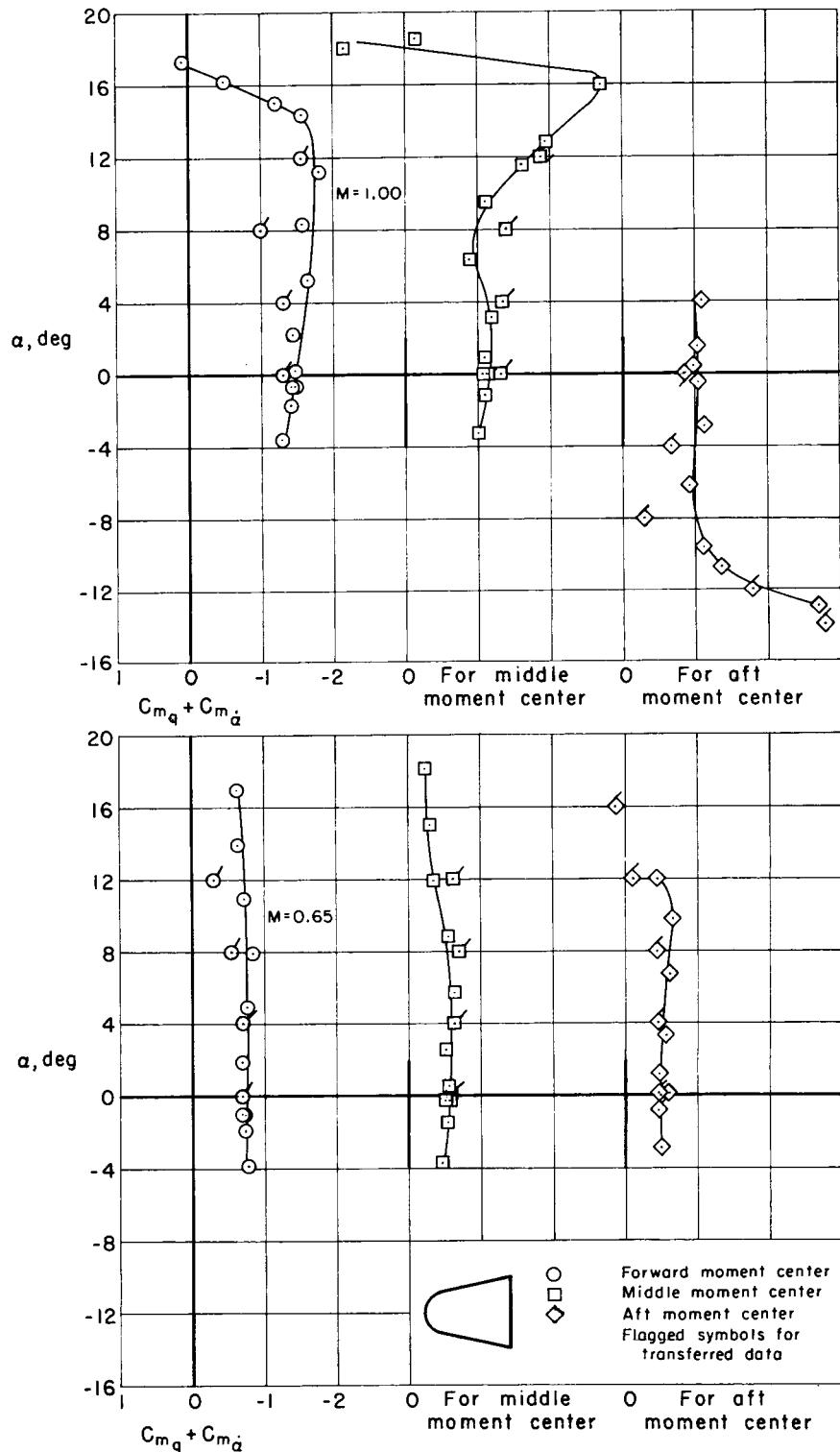
(c) Sharp cone with spherical base; middle moment center.

Figure 4.- Continued.



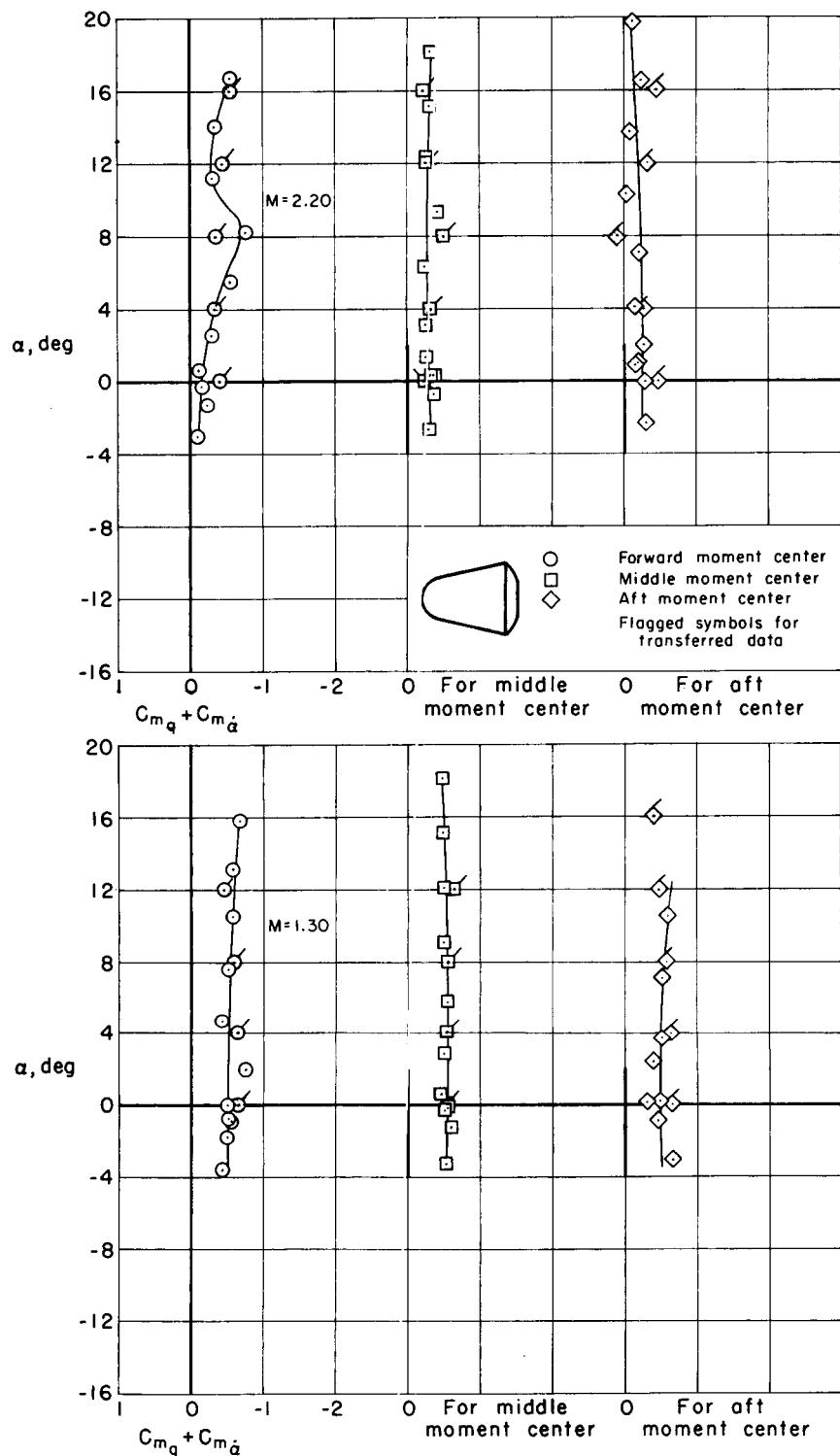
(d) Blunt cone with flat base;  $M = 2.20$  and  $1.30$ .

Figure 4.- Continued.



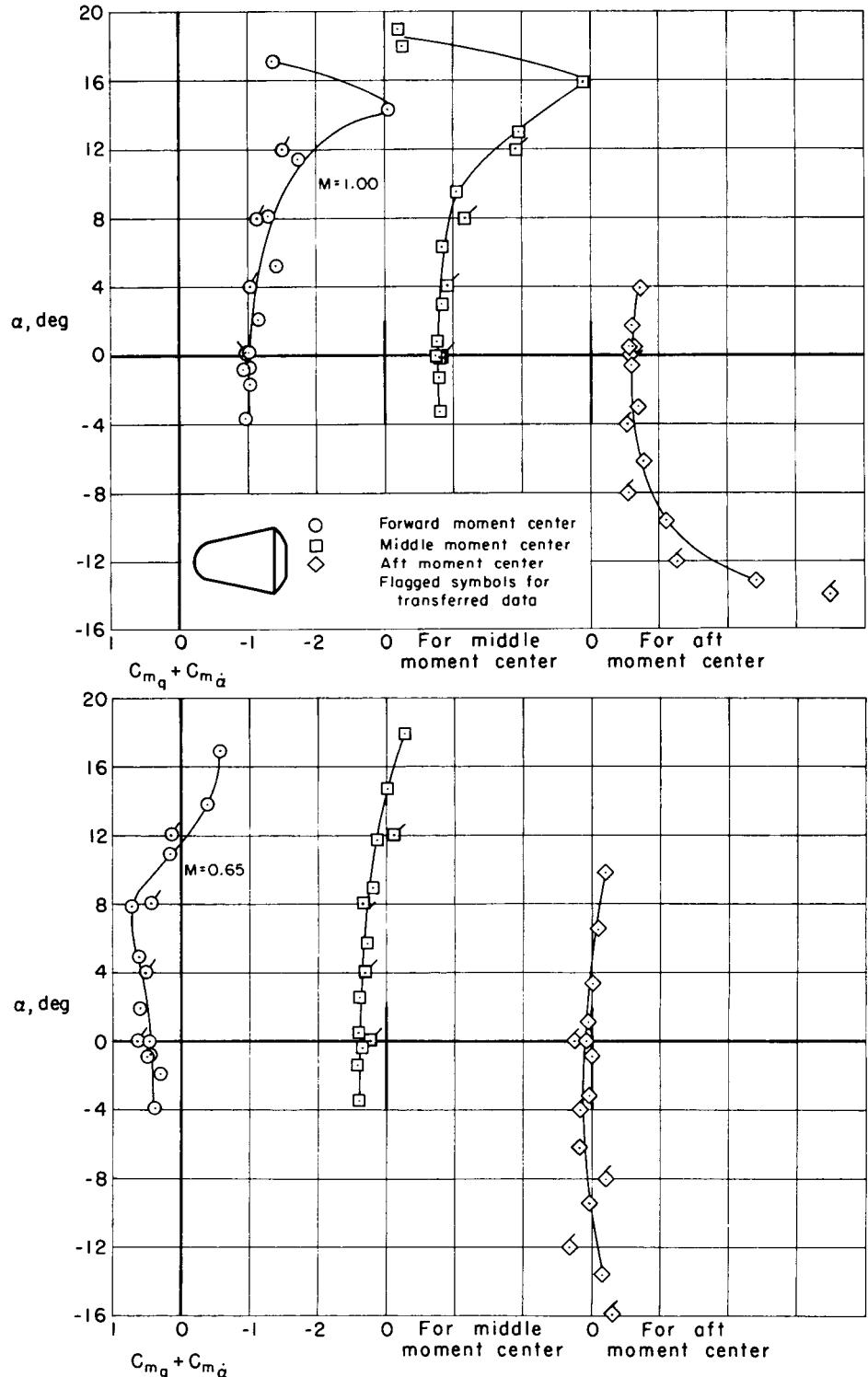
(e) Blunt cone with flat base;  $M = 1.00$  and  $0.65$ .

Figure 4.- Continued.



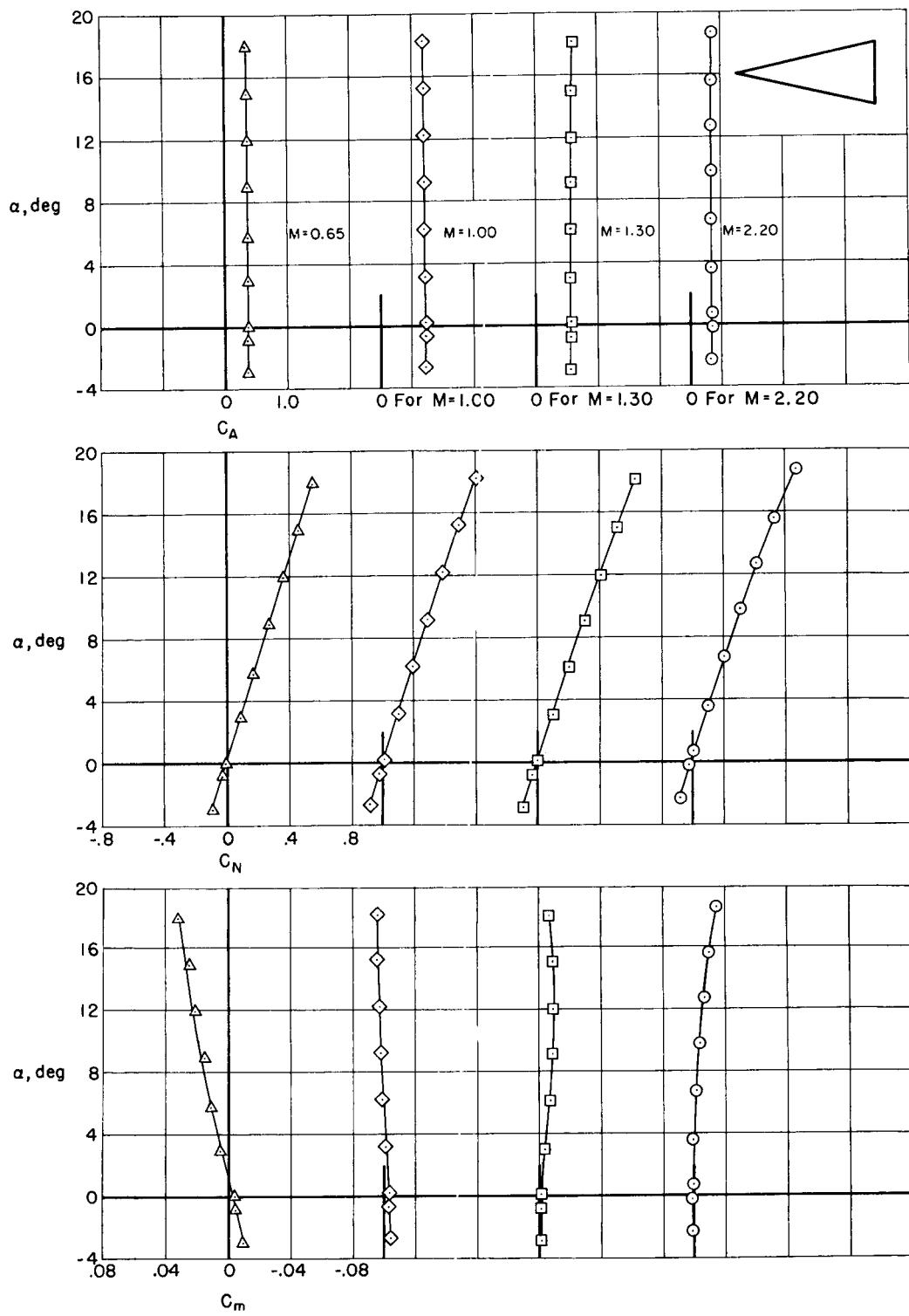
(f) Blunt cone with spherical base;  $M = 2.20$  and  $1.30$ .

Figure 4. - Continued.



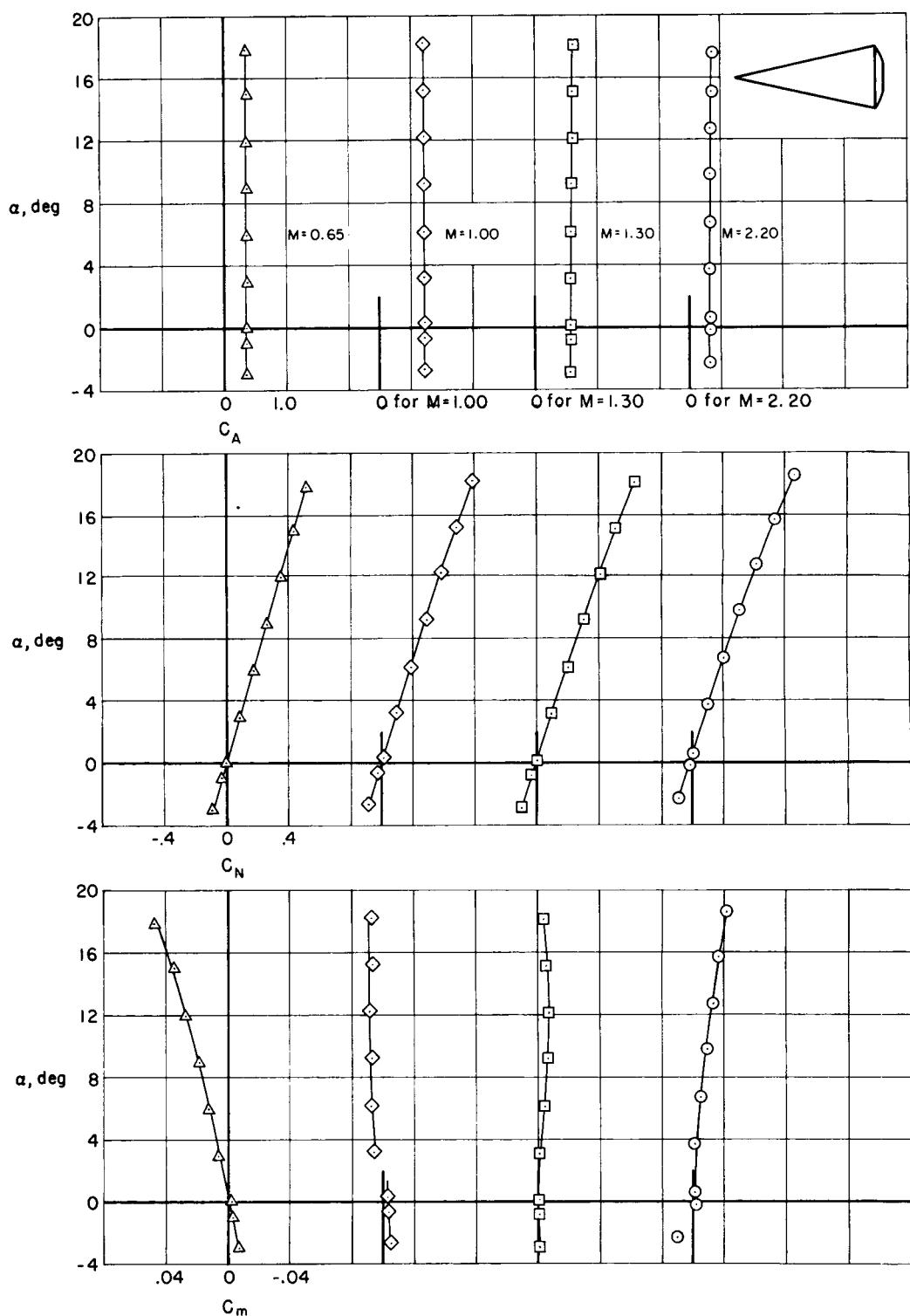
(g) Blunt cone with spherical base;  $M = 1.00$  and  $0.65$ .

Figure 4.- Concluded.



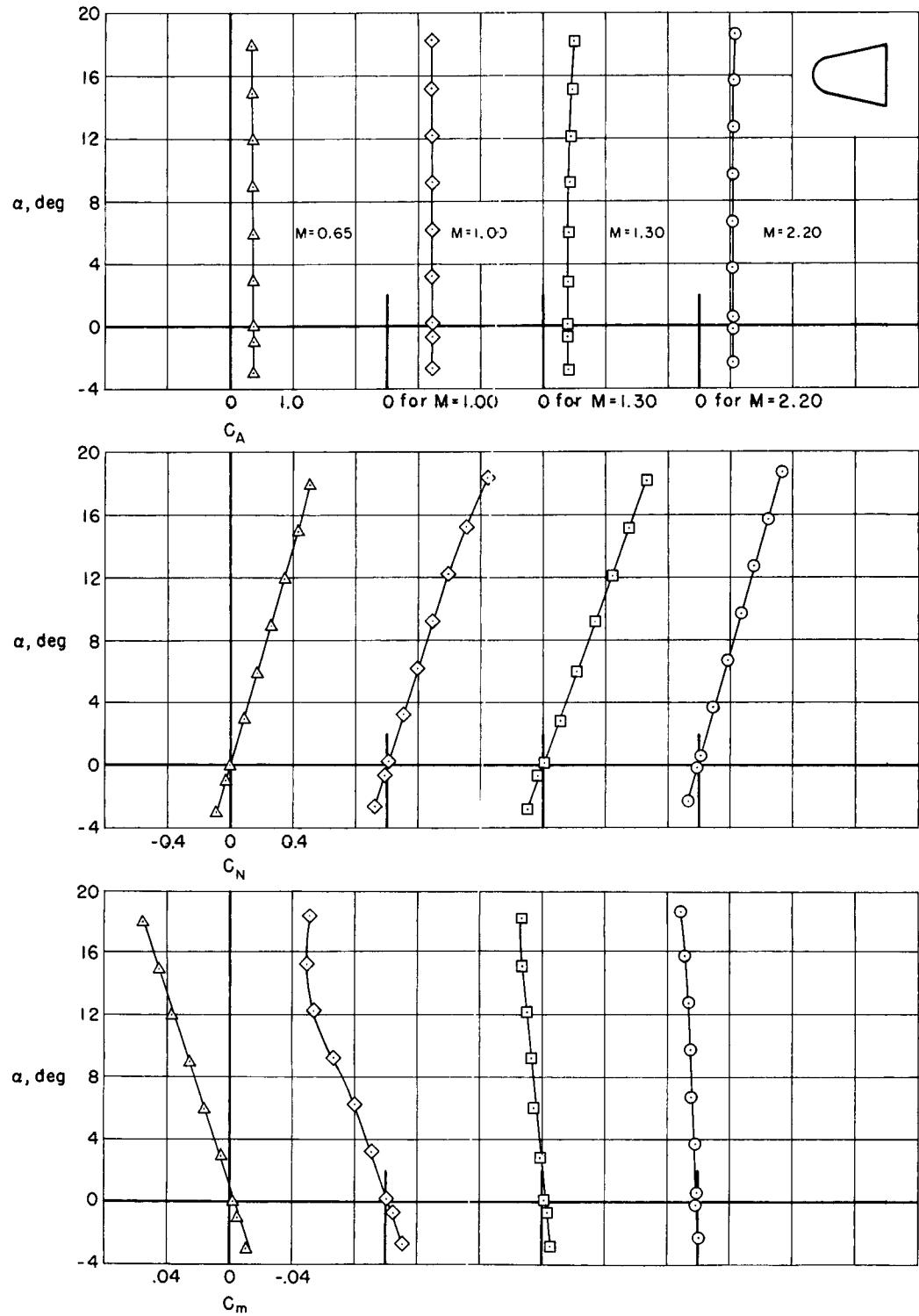
(a) Sharp cone with flat base.

Figure 5.- Variation of the static stability characteristics with angle of attack.



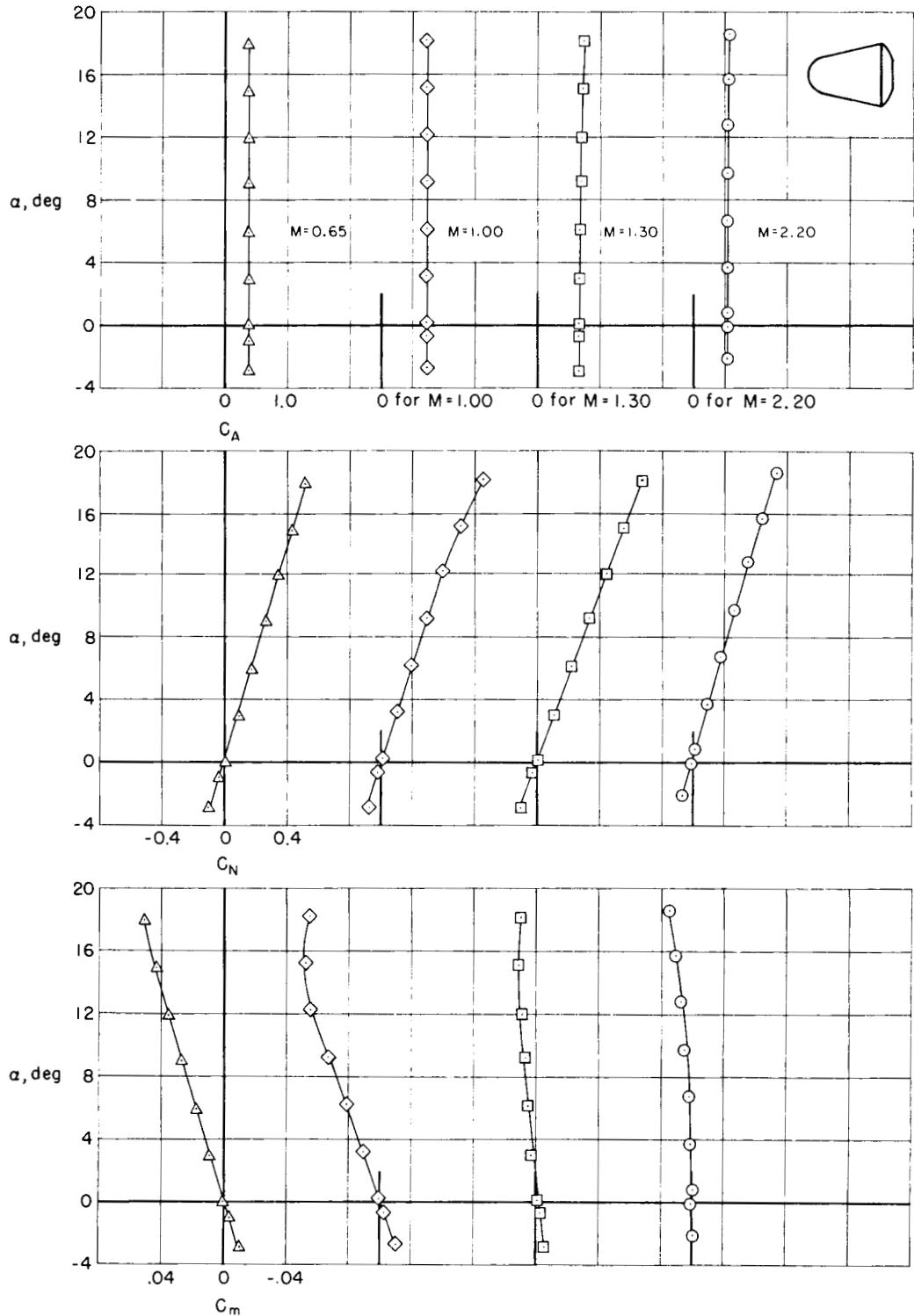
(b) Sharp cone with spherical base.

Figure 5.- Continued.



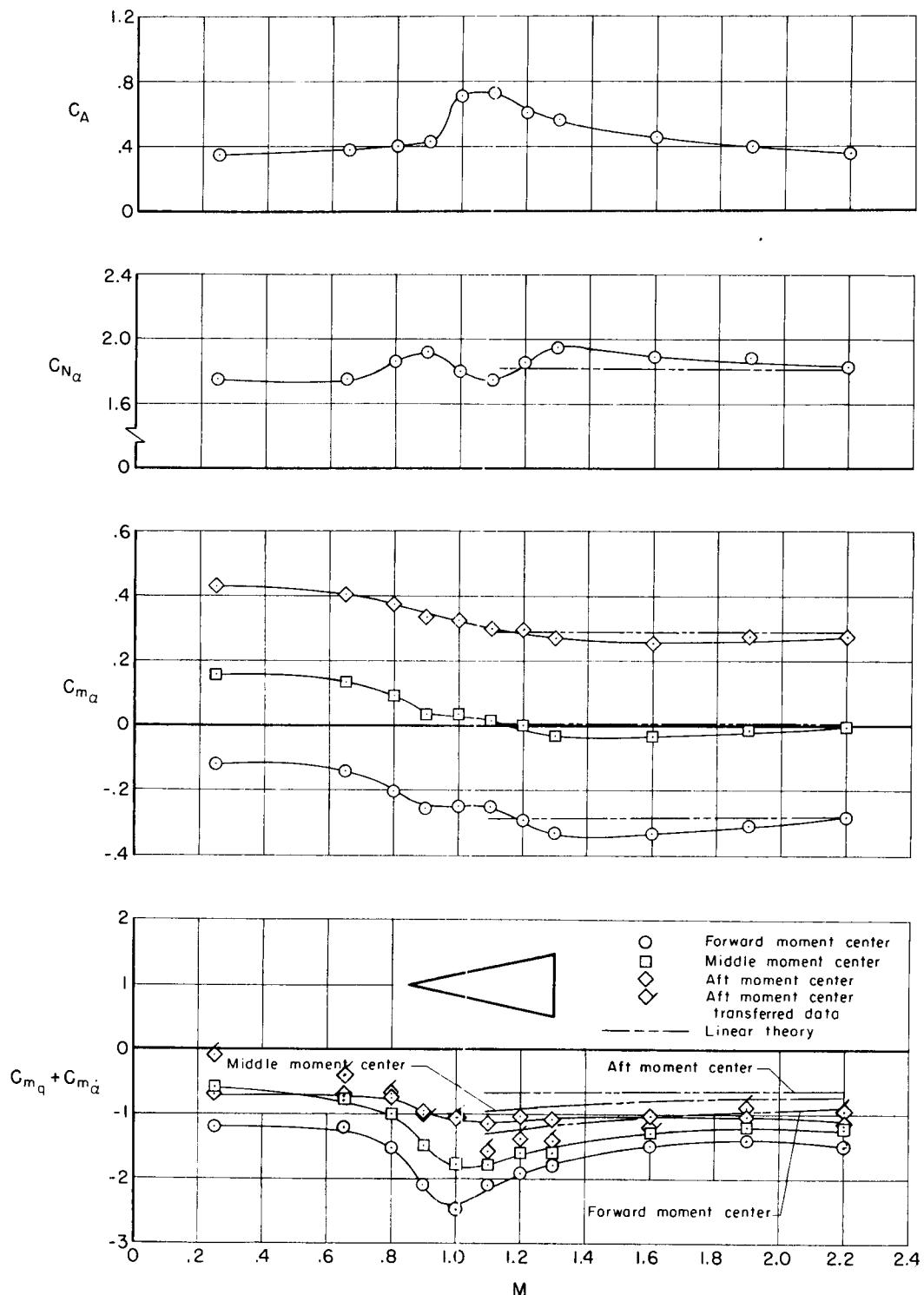
(c) Blunt cone with flat base.

Figure 5.- Continued.



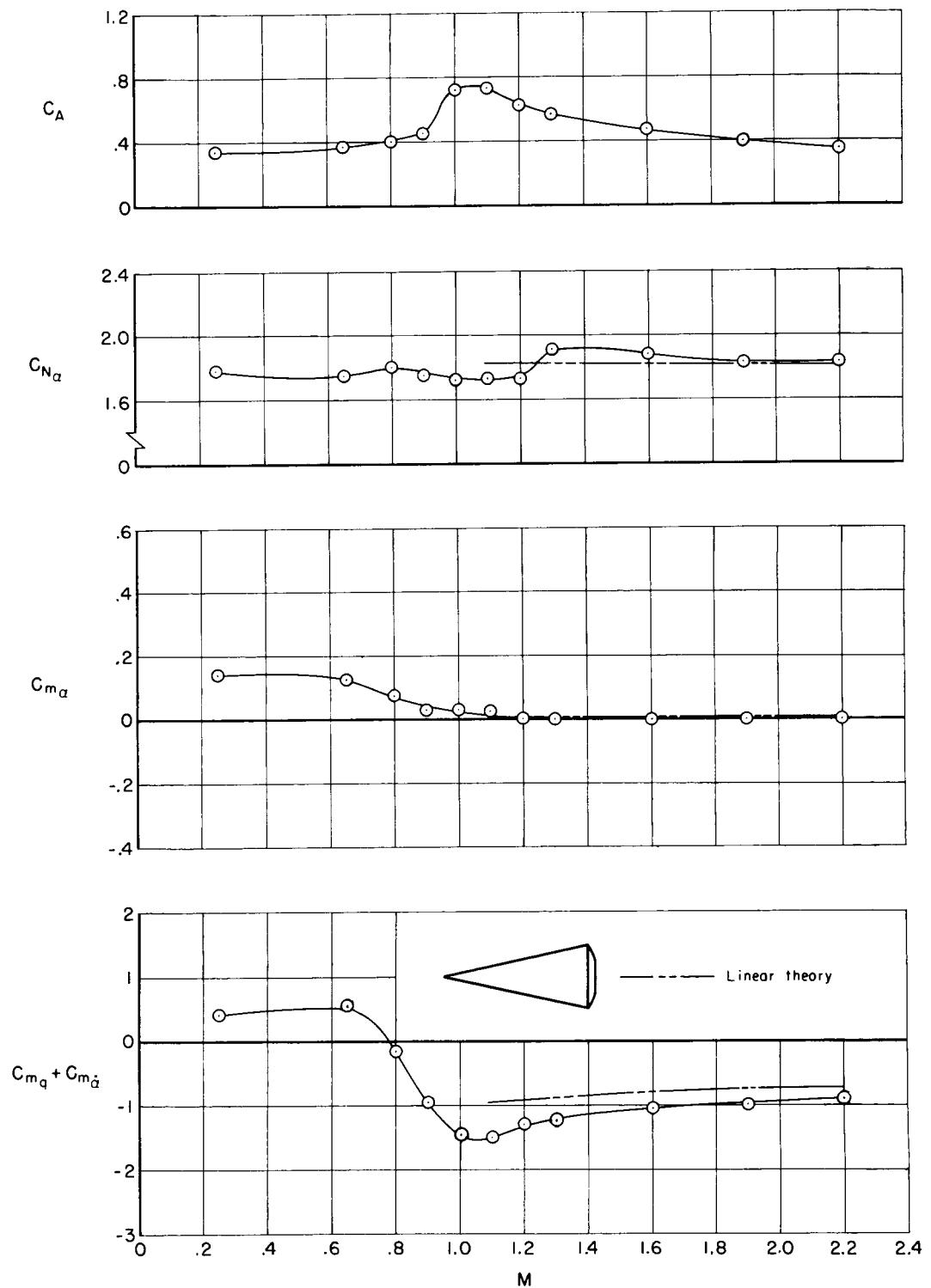
(d) Blunt cone with spherical base.

Figure 5.- Concluded.



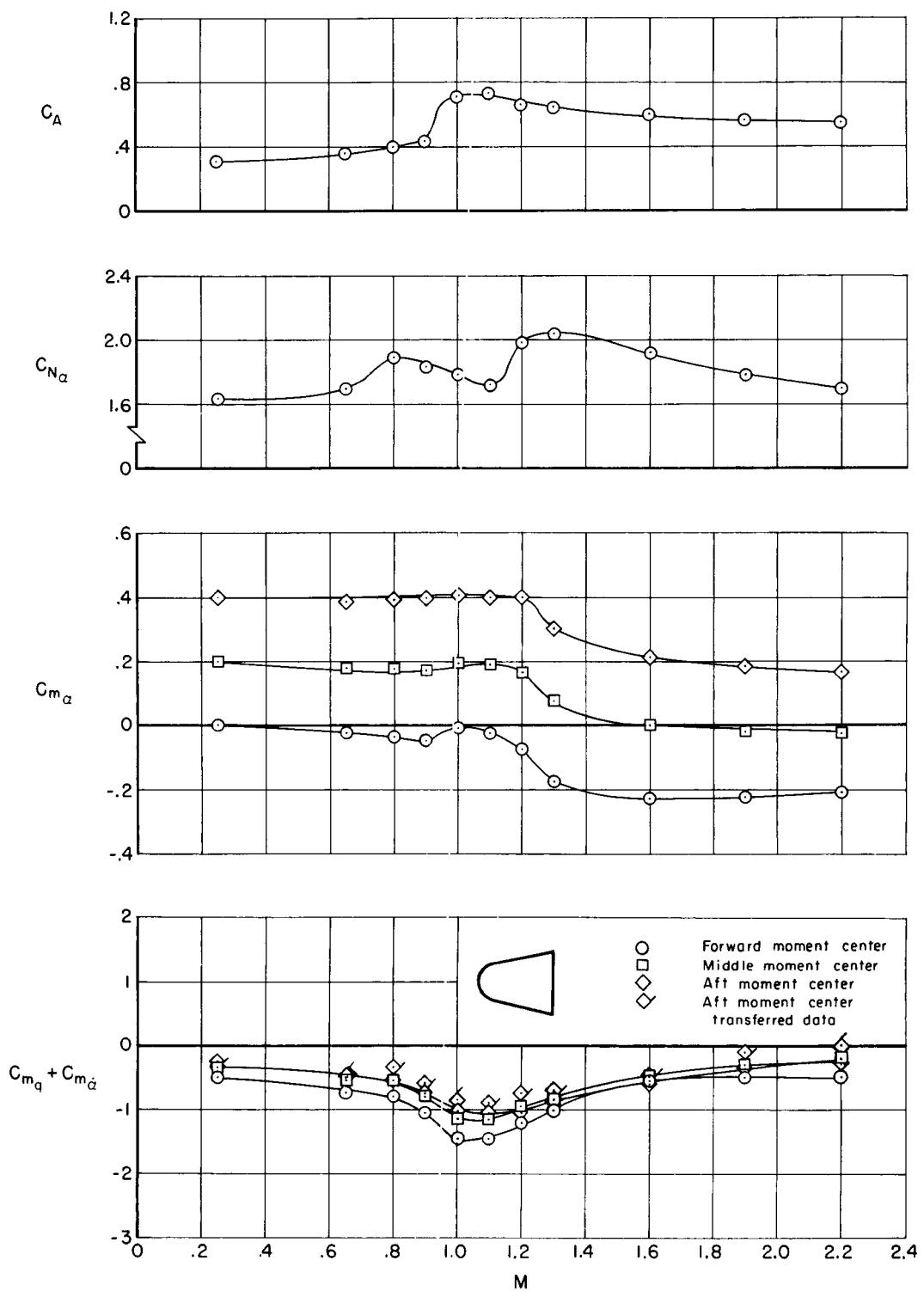
(a) Sharp cone with flat base.

Figure 6.- Stability derivatives and axial-force coefficients for model at zero angle of attack.



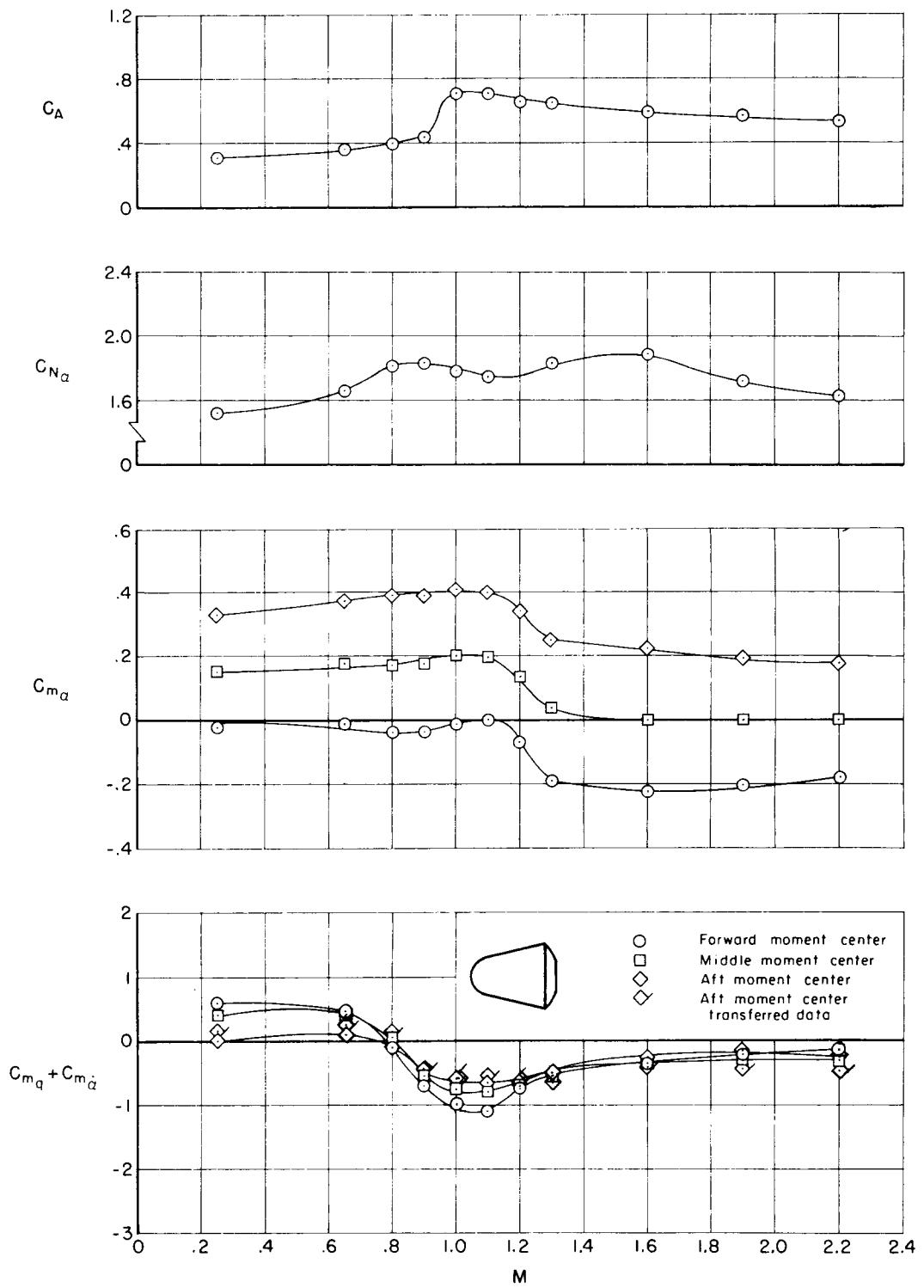
(b) Sharp cone with spherical base; middle moment center.

Figure 6.- Continued.



(c) Blunt cone with flat base.

Figure 6. - Continued.



(d) Blunt cone with spherical base.

Figure 6.- Concluded.

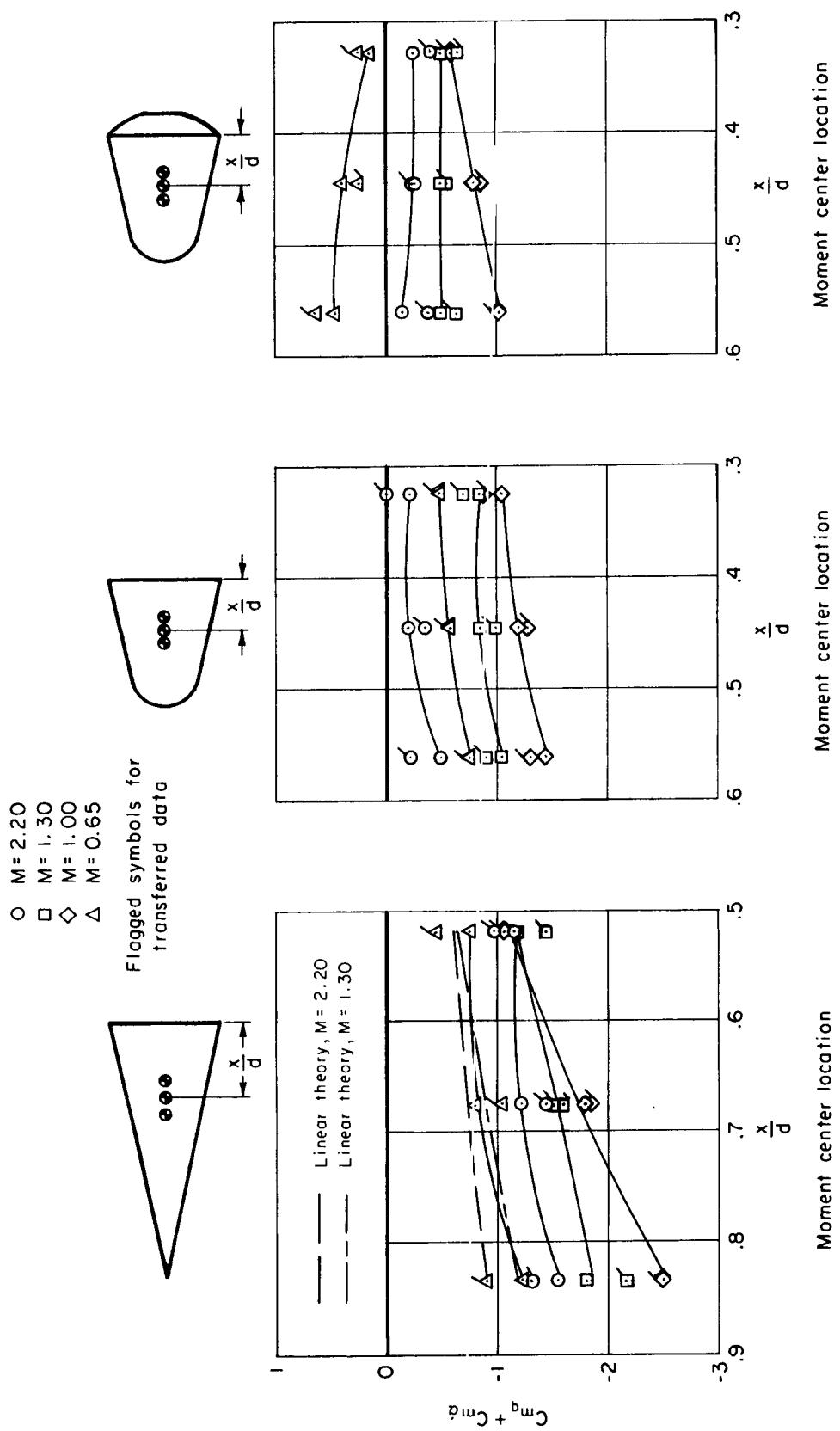


Figure 7.- Effect of alternate moment centers on the zero angle of attack values of the damping in pitch.

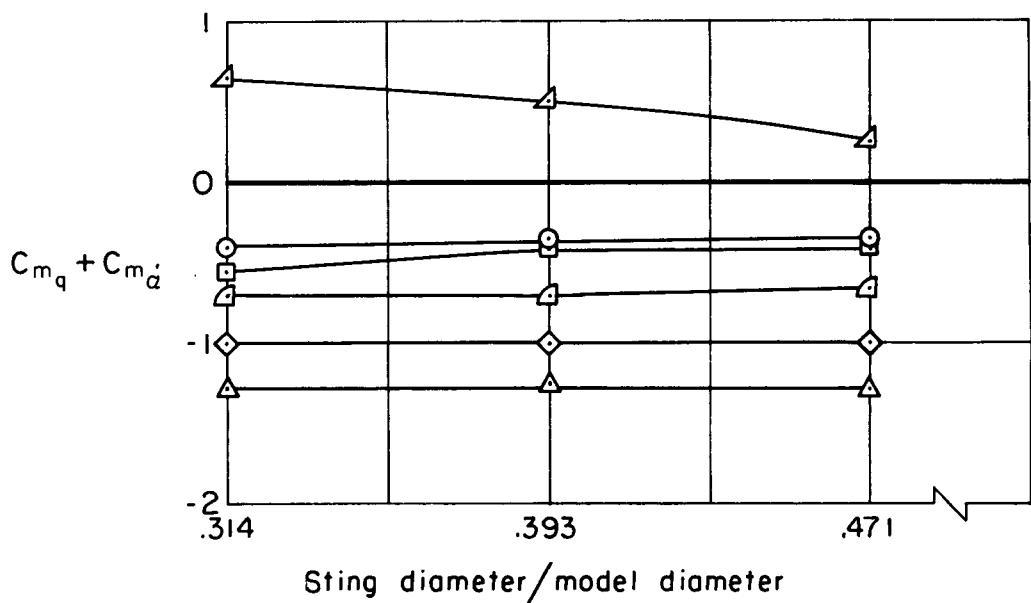
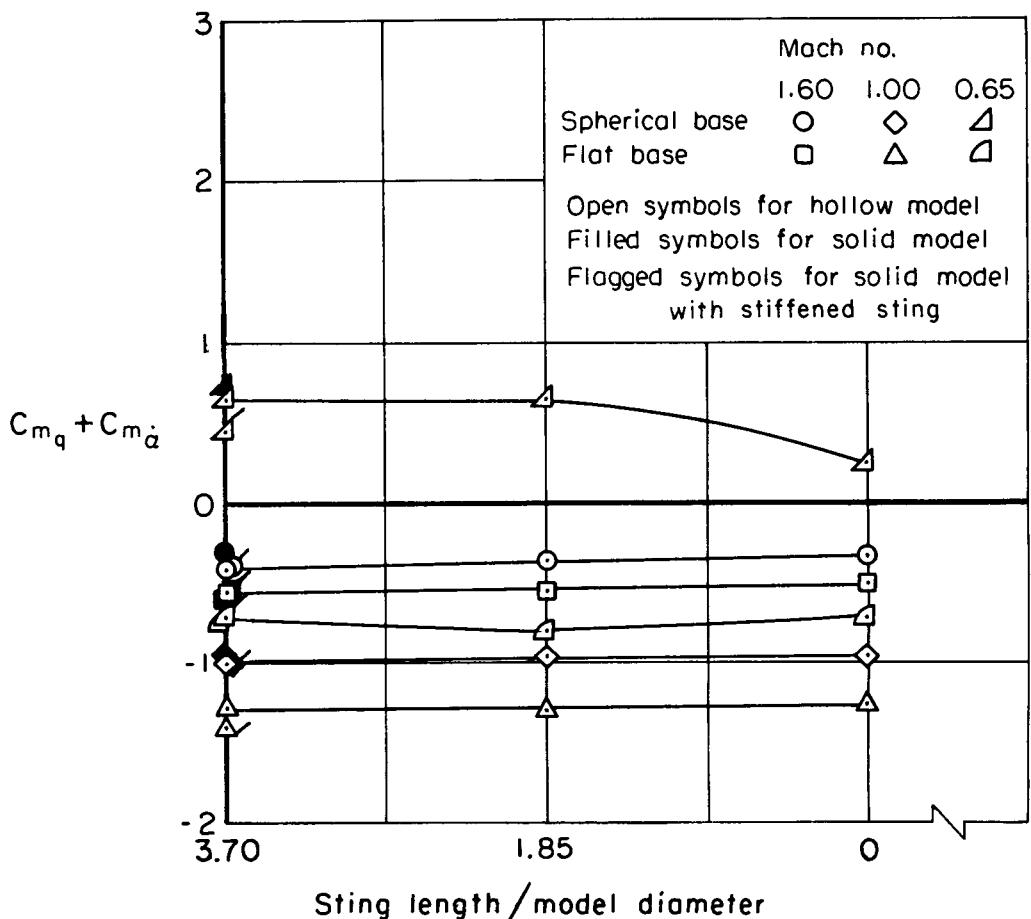


Figure 8.- Effects of sting configuration on the damping in pitch for the blunt cone; angle of attack at zero and forward moment center.